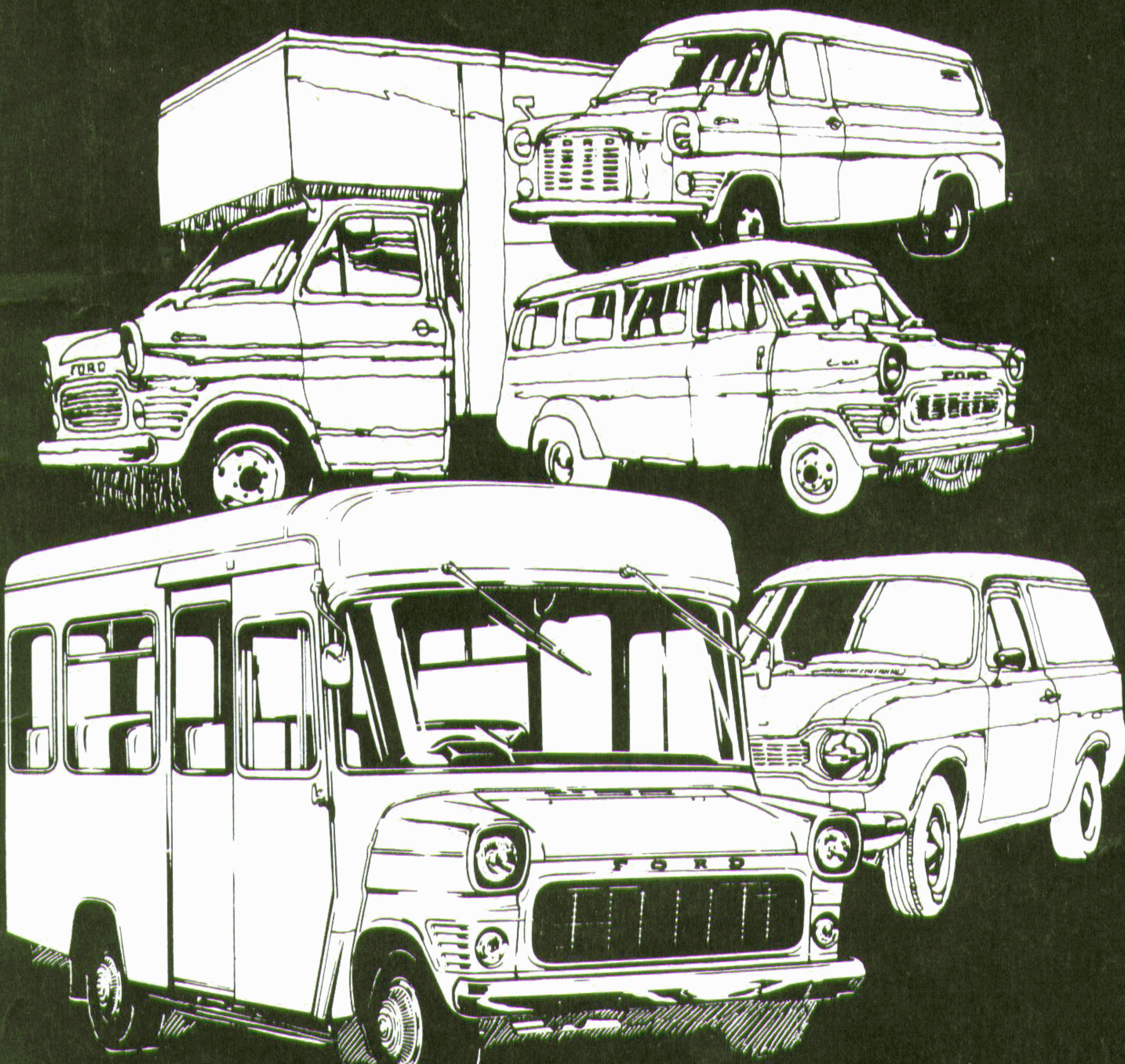
HOSPITAL ENGINEERING

April 1977

The Journal of the Institute of Hospital Engineering



Transport in the NHS

'Hospital Engineering' is published monthly, except in January and August, by Earlsport Publications

Individual copies cost
£1.70 U.K. postage paid

The annual subscription is UK: £14.50
Overseas: £17.50 Americas: $40

Average circulation per issue
(January-December 1975): 2011

ABC

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UK ISSN 0046-7960

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HOSPITAL ENGINEERING

April 1977 **Vol. 31 No. 3**

The Journal of the Institute of Hospital Engineering

Contents

Institute News

Report of the Council for 1976

Council, and Council Committees met on 23 occasions during the year.

1976 marked a further steady increase in membership, 120 new members being elected, whilst the category of membership of 25 members was reviewed.

The Institute remained a member of the Technician Engineer and Technician Sections of the Engineers' Registration Board and continued to sponsor Institute members for registration with the Board.

A dialogue was also commenced with the Council of Engineering Institutions to explore a future possible relationship.

The Annual Conference was held in Norwich and again attracted one hundred delegates. The Conference Dinner Dance was held on the middle evening and delegates, and their ladies, were guests at a reception given by the Lord Mayor of Norwich on the first evening. The special Ladies' programme again proved most popular.

Three separate one-day Symposia were held during the year, the first, in March, was held at the Institution of Electrical Engineers, the second, in June, at the Imperial College of Science and Technology and the third, in October, at the Institution of Mechanical Engineers. These meetings attracted attendances of 250, 130 and 150 respectively and, obviously, are popular and meet a need. Three further such Symposia are planned for 1977.

Although the 'Keele' Engineering Management Courses have now been transferred to the NHS Engineering Training Centre at Falfield, the Institute was associated with the Courses in certain respects and welcomes the opportunity to continue its involvement in this type of training.

The Institute continued to be represented on Council of the International Federation of Hospital Engineering and 1976 saw a further growth in the Federation which now numbers almost thirty countries in its membership. The Federation held an International Congress in Paris in January. Through its continuing relationship with, and the sponsorship of, the King Edward's Hospital Fund for London, the Institute was able to send one of its younger members to attend the International Congress.

During the year, a series of meetings was held with the King Edward's Hospital Fund and agreement was reached, in principle, on the establishment of an Institute Scholarship or Bursary and it is hoped to announce full details in the Spring of 1977.

The Northcroft Silver Medal Award for 1976 was awarded to Mr. R. C. Kensett for his Paper on 'Energy Recovery Systems for hospital use' which appeared in the July issue of the Journal.

Further books were purchased as additions to the Institute Library and the Honorary Librarian, Mr. R. G. Smith, found himself engaged in lively correspondence with many parts of the world.

During the last quarter of the year Council again discussed, and investigated, the possibility of Jewels of Office being obtained for, or by, Branches and by the time that this appears in print there will have been progress in this direction.

1976 saw the expiry of the contract with Peter Peregrinus Limited, the Institute's Publishers and after a series of meetings with them and with others, the Institute engaged the services of new Publishers, Earlsport Publications, the new Editor of the Journal being Mr. Christopher Tanous.

Council established a Working Party to draw up a submission to be placed before the Royal Commission on the National Health Service, and Council received invitations from DHSS and other Government Departments to offer comment in various fields from time to time.

Again, the Institute was invited to nominate a member to serve on the 'Watt Committee on Energy'.

The Institute continued to have representation on numerous British Standard Institution Committees.

The Presidency of the Institute

As has been announced already, Council is delighted that Mr. J. Richard Harrison CBE CEng (Fellow) has agreed to assume the Presidency of the Institute, which he will do at the conclusion of the Annual General Meeting of the Institute to be held in the Atholl Palace Hotel, Pitlochry on Friday, April 29 1977.

Council of the Institute

The following members of Council retire at the conclusion of the Annual General Meeting:

D. L. Davies, Area Member — London Branch; D. Scott, Area Member — North East and Yorkshire Branches; K. I. Murray, Nominated Member; P. C. Vedast, General Member.

With the exception of Mr. D. Scott they are eligible for re-election in their respective categories. The results of the elections to Council will be announced at the Annual General Meeting.

Auditors

The Auditors, Messrs. Moore, Stephens & Co. have indicated their willingness to continue in office.

BY ORDER OF COUNCIL
J. E. FURNESS
March 8 1977 Secretary

The Northcroft Silver Medal 1976

The Northcroft Silver Medal Award for 1976 for the best paper appearing in *Hospital Engineering* has been awarded to R. G. Kensett for his paper *Energy Recovery Systems for Hospital Use* which appeared in the July 1976 issue.

Retired Members

Through a desire to encourage, and assist, Retired Members to attend Annual Conferences of the Institute, Council has determined to ask them to pay a purely nominal Conference registration fee which has been set, at this time, at five pounds.

This is quite apart, of course, from the costs of travel and accommodation which, clearly, must be the responsibility of the individual.

Nigerian venture

Mr. P. F. Pike TEng(CEI) FITE FIHospE, at present with A. W. Sinclair & Co., Scarborough, is shortly to travel to Nigeria with his wife and family to take up an appointment with Alistair McCowan and Associates, Consulting Engineers, of Pontefract, West Yorkshire. The appointment will be for approximately two years and, during that period, Mr. Pike will be employed as Resident Engineer at the Faculty of Medicine, Ahmadu Bello University, Zaria, Kaduna State, which is in the northern part of Nigeria.

East Anglian Branch

On January 22 members visited the Norfolk and Norwich Hospital at Norwich. Mr. F. D. Blackburn made arrangements for a tour of inspection of the Hospital and in particular the recently completed 'phase K' development.

Discussion took place on the relationship between design and maintenance of engineering services in plant rooms, kitchens, CSSD and ward areas.

The visit proved to be of great interest to members and Mr. J. A. Parker, Branch Chairman, expressed his thanks to Mr. Blackburn for arranging the visit and for an interesting insight into the problems associated with design, installation and maintenance of engineering installations.

West of Scotland Branch

Fluidics and Pneumatic Control

On December 16 1976 Mr. C. H. Steele, Technical Manager of IMI Pneumatics Limited, spoke on 'Pneumatic Controls with special emphasis on Fluidics'. Mr. Steele started his paper by giving a brief description of the difference between pneumatics and fluidics. A pneumatic system was defined basically as a high pressure distributive system or power source reduced at the operating unit to a compatible pressure, while fluidics controlled the system by operating at very low pressures on the concepts (a) that a small stream of fluid meeting another will change its direction and (b) that a stream of fluid will tend to adhere to a wall (Coanda effect).

Fluidics were developed quite recently for the aerospace industry from a requirement to simplify control and power functions of hydraulic and pneumatic systems. Fluid logic components eliminate the interface between mechanical and electrical components, are therefore sparkfree and because they have no moving parts are immune to high temperature, shock, acceleration, vibration, radiation and explosive gases. In fairness, Mr. Steele said that fluidics had limitations at low temperatures and of course required air to a very high degree of cleanliness, particularly with respect to oil and water contamination. The relationship of Fluidics to Pneumatics was seen to be similar to the Electronics/Electrics relationship i.e. the former provides the brain and the latter the power.

Mr. Steele's paper was well illustrated with slides and hardware, the small size of which impressed the members present. Question time was a lively affair with Mr. Steele answering a multiplicity of questions with ease and assurance. Finally, the Chairman called for the last question and closed the meeting with a vote of thanks to the speaker.

From Pipeline to Patient

At a meeting of the West of Scotland Branch held on February 3 1977 the speaker was Dr. J. G. B. Hendry, Consultant Anæsthetist, Victoria Infirmary. Dr. Hendry first reminded those present that he was primarily concerned with the handling of anæsthetic gases from the outlet or terminal through the anæsthetic trolley to the patient, hence the subject title.

He, in common with other anæsthetists, assumed that the right gas would come from the right terminal but he did make a plea for terminal connections to be more accessible to the theatre staff. A recurring point throughout his talk was for improvements to the supply of any service to theatres, IC Units etc., and to illustrate this point he showed numerous slides showing just how cluttered an operating theatre can be with monitoring equipment, life support systems, instrument trolleys and with tubing, cables etc. festooning the floor with the attendant high risk of accidental damage to the equipment, patient and staff.

Dr. Hendry presented to the meeting a highly informative, and at times amusing, dissertation on life as an anæsthetist. He commented at some length on the scavenging of exhaust anæsthetic gases, a subject which occupied a considerable portion of question time, and he also spoke about his preference for the ventilation of patients by the volume method as opposed to the pressure method. In answer to a question on the risk of explosions in anæsthetic areas, Dr. Hendry postulated that the risk was now slight since ether was no longer used as an anæsthetic, and cyclopropane was used infrequently and in small quantities.

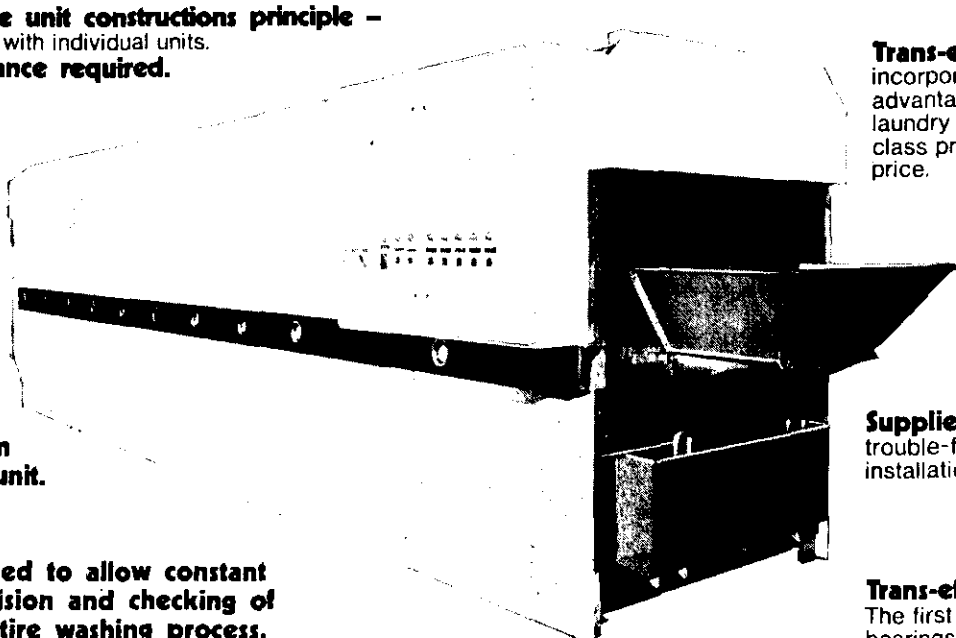
A hearty vote of thanks was accorded to Dr. Hendry, after the Chairman brought the meeting to a close, for his most interesting, thought-provoking and enlightening paper.

Insulation

At the meeting of the West of Scotland Branch on February 24 the attendance was augmented by our Building colleagues who joined us to hear Mr. Hendry and Dr. Anderson of the Building Research Establishment present a joint paper on the 'Practical and Theoretical Aspects of Insulation'.

Dealing first with the obvious benefits of insulation with respect to energy conservation, the speakers broadened the discussion by commenting in depth on the current requirements of the Building Regulations and other legislation. Some anomalies were mentioned, highlighting the gap between the minimum standards of insulation for domestic premises and those for industrial premises. The various methods of insulation used were outlined and some dramatic slides were screened, illustrating how a well insulated building could fall victim to condensation if the insulation design work was not done properly. The discussion then centred on the problem of condensation and the correct positioning of vapour barriers. In fact, during the whole of the presentation the problem of condensation was aired frequently. Mr. Hendry and Dr. Anderson outlined the theory of the thermal capacity of a building and also discussed briefly the advantages and disadvantages of interior and exterior insulation.

After a break for coffee Mr. Hendry and Dr. Anderson answered a variety of questions from the members, the Chairman, Mr. Peters, finally closing the meeting with a vote of thanks to the speakers.



Symposium Papers

The Institute held a successful one-day symposium on Transport in the National Health Service on March 2 1977.

This paper and the one that follows were both presented at the symposium, and deal with the legal and financial aspects of fleet operation respectively.

The other papers given were by Mr. T. R. Walton, Chief Officer of the London Ambulance Service, who spoke on the problems of managing a dispersed fleet of vehicles, and Mr. N. E. H. Peters, who spoke on the legal and operational implications of transport engineering. It is hoped to include the latter paper in the next issue of Hospital Engineering.

The author is a solicitor in practice at Chorley in Lancashire.

The Legal Responsibilities of Operating a Fleet of Vehicles

JONATHAN S. LAWTON MA Solicitor

There is little doubt but that the use of any type of mechanically propelled vehicle on the roads of this country, by either an individual or an organisation, attracts a greater mass of legislative controls than any other single activity. Clearly the intention is ultimately to obtain the best advantage for the public generally by ensuring that any vehicles which are so used are safe, that people who have control of them are sufficiently experienced, and that the roads upon which the vehicles are used are suitable for that purpose.

English law tends to develop on a pendulum basis, swinging between extreme controls and discretionary controls. Inevitably, the swing is always somewhat behind the public will but presently we are in a situation when the legislative control relating to motor vehicles can only be described as extremely severe.

To explain certain of the observations that will be made it is necessary briefly to deal with the question of what is known as an 'absolute' offence. A large number of matters arising out of the day-to-day use of a vehicle clearly depend upon the willingness of the driver of the vehicle to take adequate precautions to ensure that the law is not broken. Clearly one is here considering matters such as worn tyres, defective brakes, inefficient windscreen washers and matters of that sort. Notwithstanding that the operator may have issued careful and detailed instructions to drivers to ensure that they do not drive vehicles on the roads with defects, the law will impose upon those responsible for the operation of those vehicles a similar duty of care to that which is imposed upon the driver; that is to say that the employer will be found guilty even though the offence which causes the prosecution to be brought is a matter that is demonstrably outside his control.

Whilst it will be necessary to return to that point again it is convenient to make a third observation about the general background against which the law relating to the operation of vehicles must be seen. All of you will be aware of the current antagonism towards those vehicles which are described as 'juggernauts'. Viewing the matter as impartially as possible one has to observe that those who criticise the operation and use of those vehicles on our roads have conveniently managed to put from their minds the fact that without the assistance of passenger and goods carrying vehicles their life would be unrecognisable, as a result of the deprivations which we would all suffer. However, the effect of that constant public antagonism which is reflected in the daily newspapers is to produce in Magistrates' Courts a situation in which the motorist, and particularly those concerned with the operation of heavy vehicles, is at a substantial disadvantage in attempting to avoid conviction.

It follows therefore that the primary activity of those responsible for the operation of a fleet of vehicles is to create a situation in which any failure to comply with the legal requirements cannot be attributed to a failure by those responsible for the operation of the vehicles.

There are two separate areas in which legal responsibility has to be examined: the first, and greater of these, is that of the mechanical efficiency of the vehicle. The second, a rather more restricted area, relates to the control of the drivers of those vehicles.

There is no aspect of the mechanical operation of a vehicle which does not attract a legal responsibility and yet, as has already been seen, the operator will always be vulnerable to the failure of the driver to recognise and deal with defects as they occur during the day-to-day operation of the vehicle. Be that as it may the law will not, because of the use of the 'absolute' offence, see the responsibility of the driver as being an excuse. The position in any event is worsened because the prosecuting authority, normally the Police, will prefer to use the 'absolute' offence even if there is an alternative.

What can the operator do?

The answer is to construct a system whereby the wish of the operator to comply with the law can be clearly demonstrated should any prosecution be brought. Clearly the more sophisticated that system, the greater the cost. Nonetheless, the ideal can be quite easily demonstrated.

Where the operator is the holder of an 'operator's licence' he will have completed the statutory form of declaration relating to his duties to maintain the vehicles in good order, and to ensure that the drivers' records are properly kept. That declaration, which is sufficient to satisfy the Licensing Authority, will not in real terms be of any assistance before the Magistrates' Court. The same curious situation arises so far as maintenance is concerned. The Licensing Authority may well be satisfied with the provision that has been made to maintain the vehicles, because their Inspector will look at the matter in a professional sense, or at least with the eyes of someone who is aware of the problems faced by those whose duty it is to operate vehicles. Again, that understanding will not be shared by the Magistrates' Courts. For this reason, in advising those whose responsibility it is to supervise fleets, the advice must be given to guard against the inevitable reference of any shortcoming to the Magistrates' Courts.

The control and supervision of the separate mechanical functions of the vehicle should ultimately be with an appropriate expert. Provided that is done and provided that the expert can demonstrate that the vehicles are inspected at intervals which can be seen to be both reasonable and regular, the operator is in a position to minimise the effect of a prosecution and, indeed, in some exceptional cases may avoid conviction.

The expert in ordinary terms will be a garage specialising in servicing and repairing the type of vehicle which is operated; the expert will be a tyre distributor and supplier who will supervise not only the condition of the tyres but the general tyre care carried out by those responsible for the vehicles. These companies will make written recommendation as to the regularity of inspection, the regularity of servicing, and any other matters which seem to them to be necessary to ensure that the vehicles are kept in good condition. Duplicate maintenance records will be kept by the operator.

In many organisations the function of the 'expert' is carried out by an individual who is extremely highly qualified. If that is the position it is of considerable importance that the nature and interval of inspections and other work are carried out in accordance with, or more frequently than, the manufacturer's recommendations. Quite simply the situation is that no matter what personal views the operator may have as to the nature of the supervisory work, in the end the Court will only be persuaded if the supervision can be related to that which is recommended by the manufacturer.

It will be clear from this that we are paying lip service to a system rather than considering the mechanical advantages of the systems, which in any event is not a matter for this paper. The effect of legal controls must be looked at in that light because, as has already been said, it is not a situation in which the operator can defend himself against a prosecution by seeking to persuade the Court that his approach to the matter has been reasonable.

One can understand that many people who have the responsibility of controlling fleets of vehicles, and who are highly qualified, will take the view that they are better able to ensure that the vehicles are well maintained than the appropriate garage — in many cases that will undoubtedly be true. In current terms that truth is less important to the Court than the demonstration of a clear relationship between the vehicle and those responsible for its care.

There is a second matter which is not directly relevant to the issue of the legal control, but is nonetheless worth noting. It is that, in the event of a substantial insurance claim, the operator will be in a better position to deal with that claim if he has arranged for the vehicle to be maintained by those who, on paper at least, are best able to do so.

Clearly, as has already been said, the system cannot stop at the point where those regular inspections are carried out. Two other steps need to be taken.

Firstly, in ideal circumstances, there will be a periodic inspection by an independent Fleet Engineer or commercial vehicle engineer who will prepare reports on the condition of the vehicle which will override any part of the internal system. The ideal solution is to produce a report that in effect is similar to that which would be produced by a vehicle examiner, having the effect of a GV9.

Secondly, steps must be taken to ensure that drivers of the vehicles are made aware in precise terms of their own obligations so far as the condition of the vehicle is concerned. Again, to be precise, it is clear that it is not possible to ensure that a driver complies with those instructions with any degree of certainty, but the operator's concern so far as this exercise is concerned is to be able to demonstrate to the Court that such instructions have been properly given and that there is no circumstance in which the driver was prevented from carrying them out.

The driver should then be told that the condition of the tyres of the vehicle and the pressures of those tyres are his responsibility; he should be told to report any defect that he might discover on the vehicle whilst he is using it; he should finally be told that if he has any doubts as to the safety of the vehicle he should stop forthwith and telephone for instructions.

The second area of responsibility arises out of the duty imposed upon the operator to ensure that the drivers comply with the statutory regulations relating to their hours of duty and driving.

These matters are comparatively clear and basically require a willingness by the drivers to comply with those regulations or, at least, to complete the statutory records that may be required accurately and correctly.

The operator's duty is to ensure that the drivers' records are adequately checked before they are signed and that any mistake on those records is notified to the driver.

The position is perhaps rather better from the operator's point of view so far as this area of conflict with the law is concerned, because prosecutions for this type of offence will normally be brought by the Licensing Authority who, through his Traffic Examiners, will have a substantial understanding of the problems faced by those responsible for the operation of vehicles. It follows from this that provided reasonable attention is given to the supervision of those records, and provided adequate instruction is given to the drivers by way both of initial instructions and reminder, it is unlikely that any prosecution will result even where the driver has himself committed an offence. There is an interesting difference between the willingness of Licensing Authorities and their Staffs throughout the country to assist operators who may have difficulty in either understanding or complying with the various regulations and the constant conflict between the vehicle operator and the public, represented by the Police, and the impossibility of any operator constantly complying with the legal duties which are imposed on him.

Perhaps this last observation requires some little amplification. Quite simply the position is this: if a vehicle that is correctly and properly maintained suddenly develops brake failure there will inevitably be a prosecution on the grounds that the vehicle is being 'used' with defective brakes. If the prosecution is brought in that way there can be no defence and yet, if one assumes that the vehicle was correctly and properly maintained, it is clear that no further action could have been taken to avoid the commission of that offence, short of ensuring that the vehicle never in fact ran on a public road!

The legal responsibility of the operator of a fleet of vehicles is to ensure that no part of any one of those vehicles is at any time defective. The realisation of the impossibility of complying with that duty should not result in an operator taking the view that, in those circumstances, there is little point in seeking to obtain an impossible result. The duty of those responsible for the operation of those vehicles in accounting to their employers for their legal responsibilities is to endeavour to ensure that they cannot be criticised where a failure has occurred, whether it be a failure of the vehicle or the driver.

One of the papers given at the Institute's symposium on Transport in the NHS on March 2 1977.

Professor Gage is Professor in Management Studies at the Polytechnic of Central London, and a Director of H. Whitehead & Partners Ltd.

The financial consequences of transport decisions can be predicted and controlled through careful planning and well-designed management information systems. This paper discusses some of the conditions for success, starting with the place of transport in the wider context of the health service.

The Financial Aspects of Fleet Operations

Professor W. L. GAGE BEng CEng MIMechE AMBIM MIRTE

Background

The vehicle fleets for which hospital engineers are responsible provide a service. The service is part of medicare and part of the logistics of the health service. Indeed it is a small part, when judged by financial measurements such as proportion of capital investments or share of annual budget.

It is, however, an item in the total cost function of many more expensive services. The cost of linen for a hospital is comprised of:

outfit cost+laundry cost+repair cost +transport cost.

But it does not follow that linen cost is reduced if transport cost is reduced. To halve the frequency of transport services, or even impair its reliability, may greatly increase outfit cost because more linen is needed.

Taking a more grave optimisation problem, it has been shown[1] that the number of motor accident deaths is largely a function of the response time, the personnel standards and the equipment standards of the ambulance service.

Deaths/year/100,000 population = f (training), (equipment), (response time).

People will die if cheeseparing is allowed to increase response time. It is but a short step further to the inference that ambulance costs do not matter. It is difficult to know to what extent this attitude prevails in middle management in the health service. My own experience, shared with one of the Health Service Automotive Engineers, N. E. H. Peters, is that in most transport operations the maintenance of a sustained and uniform attack on transport costs is extremely difficult. Wherever there are van-salesmen there are people whose sales success is being allowed to offset high transport cost. How much trade-off is indulged for skill in the primary tasks of health service drivers?

Fleet composition

The road transport operated in England comprises[2], to the nearest 100:

Private Cars	3500
Ambulances	6600
Motor Cycles	100
Sitting Case Vehicles	1500
Tractors	400
Goods Vehicles	2700
Unclassified	700
	15500

The variety of specifications, operations, crew skills and maintenance requirements can be inferred from this analysis. The families arising within the analysis could be described as:

Emergency (some of the ambulances);
Scheduled (some ambulances, most of the sitting case vehicles, some cars, cycles and goods vehicles);
Support (the remainder).

Service and cost targets

In each type of fleet operation the service to be provided will be decisive in determining costs. It is impossible, therefore, to control costs without controlling service levels. In the case of emergency services, the Cranfield Research Report[3] suggested that standards should be set and controlled for Activation Time and Response Time. These measurements were defined, and achievable target response times suggested as follows:

Metropolitan
50 percentile at 7 minutes
95 percentile at 14 minutes
Rural
50 percentile at 8 minutes
95 percentile at 20 minutes

These standards are so similar to the recommendations of the US Bureau of Health Planning that they may be taken as a responsible assessment of the service a developed country should aim to provide. Their use as measurements was recommended by DHSS in 1974[4] and although the adoption of targets is not required, the Cranfield figures were quoted as illustrations.

Ambulances are the largest group in the fleet, and it was appropriate that the Cranfield OR Unit was asked to make recommendations for controlling this segment. The category of ambulances may be further analysed[2].

Type 1 (for emergencies)	3500
Type 2 (sitting cases and stretcher)	2300
Other	800
Total	6600

The response time measure of service level will provide a basis for the control of Type 1. The non-emergency work normally carried out by Type 2 was also considered, and the measurement recommended for non-emergency service of patient conveyance is based on departure from intention as to arrival at treatment centre.

Metropolitan
95 percentile for planned journeys @ 40 minutes late
95 percentile for special journeys @ 20 minutes late
Rural
95 percentile for planned journeys @ 60 minutes late
95 percentile for special journeys @ 30 minutes late.

Politically it is difficult to say we will provide for 95% of the country's emergencies to be reached within 20 minutes and 90% of non-emergencies delivered under one hour late, at a cost not exceeding £80,000,000 as current expense and £8,000,000 for capital investment[5]. It is, however, implicit as a target for top management. It has to be made explicit as a target for all management, the bottom line of the corporate plan for the transport fleets of the health service. If it is not set as a target any manager in the service can trade off the costs against the service level until the system goes out of control.

There are two other fleet categories for which objective standards of service are obtainable. The majority of the goods vehicles are susceptible to road transport work measurement techniques as provided by the author's consultancy to various transport fleets. Similar work has been carried out to study tractor work in local authority parks service, which may well prove applicable to many of the tractors used in the health service. The target for these segments of the fleet then becomes achievement of standard performance.

The plea for targets is not a particular need of the health service. It is a requirement for management control of any system. Whether or not an organisation is committed to a formal Management by Objectives programme (as recommended in R. G. Bassett's book on Road Transport Management and Accounting[6]) the job descriptions for the senior people must specify key results. Their attainment will be more easily managed if they are quantified, both as to service and cost.

Operations information systems

The service provided largely determines the cost. To improve the London Ambulance Service response time to 95% at four minutes would add to costs by some 50-75%. There has to be a recognition that improving the service by providing two outpatient buses per day to all areas would add considerably to costs. Costs are pre-empted by top management decisions on the community service which they perceive themselves as required to provide.

At a given level of service, the next major cost generator is the marginal unit in the fleet. To take two vehicles and their crews away and see what happens has often proved salutary. As a vanboy the author was able to observe the effect of withdrawing crews and vehicles from a civilian fleet in 1940/41. The cost per parcel delivered dropped from 1s 6d to 6d, without abandoning daily delivery.

The crew costs are more important than those of the vehicle. The relative costs are indicated by:

Crews 65%;
Running 12%;
Other 23%.

The value analysis (or big spender) approach must therefore be to improve crew rosters before turning to fuel consumption. But the cure (of transport management effort) should not be worse than the disease, so it would be helpful to know if there is a disease. Hence the 'league table' approach to management statistics which showed[7] that ten years ago Canterbury was the dearest town and Bolton the cheapest. The costs at Bolton were such that it would not have been justified to retain management consultants, whereas Canterbury probably needed help.

The financial figures provide a prima facie criticism, but road transport cost figures need to be interpreted in the light of the way the fleet is utilised. With crew costs and fixed costs so high, the usual per mile and per patient ratios are very vulnerable to poor utilisation. The need for operational information to help interpret the figures is fully recognised in the comparative costs and statistics which are extracted. A current issue for five counties (Appendix A) shows:

County	*Cost per patient*	*Miles per patient*
Hampshire	£4.00	8.77
Surrey	£4.20	8.25
Lancashire	£4.27	5.66
Kent	£5.08	7.43
Essex	£5.47	10.31

At the next lower level figures are required to measure fleet availability and downtime to monitor utilisation. It may be that nightshift repairs are necessary to obtain proper performance.

For ultimate financial control it is necessary for top management to search for correlations within the operational information. But the profile of achievement by the managers in these counties cannot be complete without service level measurements.

Staff relations

The trend of financial reports for Essex, when related to its tight fleet (0.11 per 1000) and budget (£1,629 per 1000), may have helped to cause the parliamentary question about the strength and distribution of its ambulance stations[8]. From the government reply we may infer that there is an ambulance station with one vehicle and five crew, unknown to the author. Perhaps small is beautiful; the vehicle and its equipment obviously cared for, with helpful collaboration about roster and efficient routes.

If crew costs are important, then the allocation of work by rosters and controllers can affect costs. The controller's decisions are not negotiable, but the policies for rostering and control should be agreed in consultative committee. Participation in work design is important to reduce alienation and gain staff co-operation.

If middle management feel humbugged (by incompatible demands for service and economy) and if the crews feel humbugged (because the reasons for rostering and scheduling are not worked out with them) then staff morale will be unlikely to cope with any changes aimed at cost-effectiveness. They may be asked to try to cover with a smaller fleet, or to co-operate with part-time personnel, during the implementation of change proposals.

Transport is particularly vulnerable to poor staff relations, because of the difficulty of providing career development opportunities for the vehicle crews. This should be made explicit in consultative committees, and the duties perceived as promotion should be handled carefully and justly.

a. Terotechnology

N. E. H. Peters has emphasised[9] the need for a cradle-to-grave perspective if equipment costs are to be optimised. The Department of Industry endorses this approach by sponsoring Terotechnology which deploys engineers, accountants and managers in search of the lowest total cost of providing physical assets for accomplishing work. The subject is well covered by Mr. Peters and other authorities, so it will be sufficient to extract three themes which are important to the aims of this paper.

Professional Engineering Standards

There is a body of scientific knowledge about road transport equipment design and maintenance. In Britain it belongs to the chartered mechanical engineers, usually enrolled with the Automobile Division. This knowledge is being applied to the Health Service fleet management. It is the theme of the Hospital Engineering Symposium in the year when John W. Furness is on the Council of the Automobile Division of the Institution of Mechanical Engineers; terotechnologist par *excellence!*

Replacement Policy

One of the tasks of the engineer is to analyse the interdependence between replacement policy and maintenance policy. The Secretary of State[10] tells us ambulances will be replaced after 140,000 miles or seven years. From this, follow the maintenance budgets, overhaul programmes, campaign changes, parts re-order levels and many other operational decisions. If the Secretary of State does not deliver the capital to effect these replacements, or even if he procrastinates until the lead time is prejudiced, financial control will be frustrated.

Financial Management Techniques

The terotechnology movement has found that maintenance engineers often lack information which they need to optimise total service cost. The illustration above of the effect of replacement policy envisages a government changing its overall capital budget in the public sector, probably to avoid borrowing more money itself. This implies that the cost of a vehicle in the Health Service is:

PURCHASE PRICE
+ INTEREST ON PRICE (7 years)
+ Other fixed costs over 7 years
+ Crew costs for 7 years
+ Running costs for 7 years.

If the vehicle is a borderline case for being written-off after an accident, the decision rests on the total cost (on a discounted cash flow basis) for providing a vehicle for the remainder of its seven-year life compared with the cost of a new vehicle over the same period on the same basis. No doubt a simplified decision rule will serve the purpose, but the general point to be considered is this: is there needless tension over investment decisions because operation managers do not know enough about the costs of vehicles, plant and buildings?

b. Records

There is a tendency for this genuine requirement for necessary information to lead to excessive expenditure on record keeping. The regular records should be confined to those which are certain to be needed, it being understood that supplementary investigations by Management Consultants, management services staff, or university or polytechnic research units will be applied to special studies.

Regular records will then be limited to those serving statutory requirements, management information systems and operations information systems, and most of them will be in the accounts and the established measures of fleet achievement — mileage, patients carried, consignments delivered, fleet available, days lost, response time, arrival delay, and blameworthy accidents. If in doubt, the criteria should be whether the information will sustain corrective action known to save more than the cost of the record. Corrective action implies management with authority to reallocate resources, therefore the unit fleet would appear to be the depot or ambulance station to which a transport or station officer is appointed.

Some primary records for depot operations and maintenance management are necessary; in particular it is vital to have vehicle repair histories, and fuel consumption records. In some cases it will be necessary to have time sheets, requisitions and the appropriate system for charging. If possible, however, the basic records only should be kept, without costing or reconciliation with the accounts except for audit exercises.

The benefits ascribed to individual asset costing are not usually realised. If BLMC LD Regd. No. ABC 123G cost £750 to repair in 1976 does that mean it is costing too much and has to go, or having been refurbished must last for eight years? If records prove beyond doubt that Daimler DE 27 DC was the most economical vehicle, what can be done about it? Time passes, policy changes, and the cost records are not used as claimed.

The VIMAS (vehicle information management accounting system) is one of several well designed computer packages available for comprehensive recording, but is unlikely to be advantageous. SPD has a computerised operational information system, which its "managing director acknowledges . . . does not make his the cheapest delivery service".[11]

Sub-contracting

It has been argued that the operational objective that underlines financial success is good utilisation. Good utilisation is unlikely where there is no sub-contracting.

If all resourcing has to cover peaks demanded by 95% adherence to service levels, then there will be under-utilisation when demand is low. Society is prepared to pay for this in fire brigades and commuter railways. What should policy be for health service transport? Taking resources in descending order of cost, the first opportunity to sub-contract is tested if an ambulance and crew are withdrawn from a station and the requirement is met by St. John's or by hiring from a private ambulance operator; or if a bus is withdrawn, and hiring from National Bus is permitted; or a van is withdrawn and hiring from a rental agency is authorised. A tight fleet with authorised hiring can hold costs. Second order savings can be obtained by sub-contracting crew duties. If recently retired staff or volunteers can be used, considerable improvements in financial performance are possible.

The budget for an American service[12] shows what can be done.

Annual costs for one ambulance needing coverage for two crew:

	All Employees	*Some Volunteers*
Crew	$24,000	$15,000
Fixed Costs	$8,000	$8,200
Fuel and Maintenance	$1,500	$1,600
Sub-total*	$33,500	$24,800

*These costs exclude finance, depreciation and overheads assumed to be constant. It may be argued that vehicle/equipment life would be shortened. The British Hospital car scheme and Red Cross services presumably give similar benefits.

The third level of sub-contracting is for repairs, and this form is widely practised in Britain.

Finally it may be possible to sub-contract clerical services to the GLC VIMAS service, or to one of the several bureaux offering fleet management information packages.

There are objections to all these sub-contract modes of resourcing, and for some of them the unit cost in isolation is high. Research, testing and staff negotiations are precursers to their adoption. But the financial consequences of never sub-contracting ought to be ascertained.

Budgets

The standards of the health service are a national concern, to be set at political levels. The standards of support services provided by goods transport may be objectively set through Work Study.

The budgets for achieving these targets, and other services less susceptible to measurement, should be set in money by the cost centre manager in conjunction with his superiors and his own team.

He will need clear decisions, in advance, on service level and capital planning. He will need an accounts code with the minimum number of items consistent with his need for feedback and his depot organisation for delegation.

If unfamiliar with budgets as a management tool it may take two years to attain ± 10% on the aggregate and ± 10% on 90% of the individual codes.

Help must be provided in implementing the scheme and in interpretation of feedback. The seniors should give steady, non-competitive support for his efforts on service and cost, and his achievements should earn recognition.

Summary

The transport fleet management task is to provide an acceptable service at acceptable cost. The measures needed for financial control will take effect only if the service level is first specified and then brought under control.

The Cranfield study provided measurements for about 40% of the health service fleet, and work measurement could provide a standard for about another 20%. The other services should be specified as closely as possible, with further Operational Research where it appears that measurement could be improved. The Hospital Engineer or Transport Engineer should be involved in setting and interpreting these standards, in order that the management process may benefit from their being in the problem-solving groups and in order that they can apply the cradle-to-grave approach of terotechnology.

The work will be undertaken from local depots which may be ambulance stations or hospital transport units or ancillary service undertakings. These should be recognised as the level at which dispersed fleet management[13] occurs.

For the local fleet manager to handle the financial aspects of his operations he will need to prepare, with participation from his own staff and from above, an agreed budget which includes the treatment of finance and establishment costs. Appropriate feedback on (a) the attainment of depot service targets and (b) budget variances will then provide the management information system.

The frequency and detail should be planned to suit the information requirements of the unit managers; in the longer run it is likely that they will need a computer terminal for interrogation of a model which provides restricted, essential reports in real time.

Appendix A

Ambulance Service — Comparative Costs and Statistical Information 1975/76

	Ambulance Service				
	Surrey	Hampshire	Kent	Essex	Lancashire
Net Expenditure	£2,332,359	£2,442,789	£3,219,377	£2,298,805	£2,815,645
Total mileage	4,581,544	5,353,681	4,702,743	4,332,055	3,728,877
Cost per mile	£0.51	£0.46	£0.68	£0.53	£0.76
Number of patients carried	555,296	610,531	633,352	420,243	658,648
Cost per patient	£4.20	£4.00	£5.08	£5.47	£4.27
Average miles per patient	8.25	8.77	7.43	10.31	5.66
Population served	1,001,000	1,450,800	1,445,200	1,411,000	1,369,200
Cost per 1,000 population	£2,330	£1,680	£2,228	£1,629	£2,056
Total number of staff at 31.3.76	445	489	658	477	649
Operational staff	370	413	599	407	509
Other staff as % of operational staff	16.9	18.4	17.7	17.19	27.5
Total staff per 1,000 population	0.44	0.33	0.46	0.34	0.47
Number of vehicles	127	148	251	160	223
Number of vehicles per 1,000 population	0.13	0.10	0.17	0.11	0.16
Number of miles per 1,000 population	4,577	3,690	3,254	3,070	2,723
% of patients to population served	55.5	42.1	43.8	29.78	48.1
Mileage covered — directly provided vehicles only	2,285,304	2,289,781	3,854,864	2,926,899	3,532,595
Average miles per vehicle	17,995	15,471	15,358	18,293	15,841
Cost of salaries and wages	£1,741,259	£1,769,615	£2,583,748	£1,818,845	£2,254,048
Cost per mile — based on total mileage	£0.38	£0.33	£0.55	£0.42	£0.60
Other Expenditure	£591,100	£684,700	£640,458	£481,356	£589,581
Cost per mile — based on total mileage	£0.13	£0.13	£0.14	£0.11	£0.16
Running costs	£168,721	£115,472	£256,648	£221,600	£295,619
Running costs per mile — based on directly provided vehicles only	£0.07	£0.05	£0.07	£0.08	£0.08

NOTES:

1. Lancashire training centre caters for students for whole Region and bears total cost.
2. Lancashire use hospital car service to a very much lesser degree than other Areas.
3. Lancashire has influx of holiday makers during summer which increases long distance removals to home addresses in the case of sickness or accident to visitors. This may also apply, perhaps to a lesser degree, to other Areas.
4. Lancashire and Surrey HQs are situated some distance from Area HQs, therefore extra expenditure can be involved.
5. Surrey. The extra cost incurred in respect of London Weighting is approximately £93,000.
6. Essex. Maintenance of vehicles is carried out by Essex County Council.

Acknowledgements

Among the contributors to this paper, the author wishes to thank:
Jennifer Beardwood, Management Library, PCL;
Roland Bream, Harold Whitehead & Partners Ltd.;
Vincent Camroux, Finance Officer, London Ambulance Service;
Peter Goldschmidt, Policy Research Incorporated, Baltimore;
J. D. W. Mann, Statistical sections, DHSS;
John Murdoch, Cranfield Institute of Technology;
John O'Hagan, Kenton Ambulance Station;
Nigel Peters, on secondment to London Ambulance Service;
The DHSS Library at the Elephant and Castle.

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Mr. Burke describes how the transfer of the Keele Courses to the Hospital Engineering Centre has been achieved without loss of identity or effectiveness and is now a matter of history.

Mr. Burke, formerly Regional Engineer to the East Anglian Regional Hospital Board, is now seconded to the DHSS on special duties. He has been closely connected with all aspects of engineering training since 1957 and has been involved with the Keele Courses since their conception.

'Keele' Courses at Falfield

MAURICE J. BURKE OBE AMIEE FIHospE

It was with a tinge of regret, and one might almost say a sense of foreboding, that those of us who had been associated with the Keele Courses received the news that they were to be transferred to the Hospital Engineering Centre at Falfield in 1976. For 11 years these courses had been organised by the Institute of Hospital Engineering, in conjunction with the Department of Health, during which (with one exception) they were held at the University of Keele — hence the name. Even the 1965 Course at Nottingham University became known as the Nottingham 'Keele' Course.

We came to look upon Keele as the proper place for such an activity, offering many advantages over anywhere else. It was reasonably central, with good access from the M6 and from Crewe for those who came by train. It offered amenities and accommodation; it was a growing campus in pleasant surroundings, but above all it had the indefinable aura of a University. Many of those who have attended (well over 2,000) would have been unlikely to have had any other chance to live and work in a University.

Against this background, it will be appreciated that some of us viewed with apprehension the move to the Hospital Engineering Centre at Falfield; it had been seen to be inevitable soon after the HEC was established, and to put it bluntly we doubted if the transfer could be made without losing the very special (and peculiar) character developed by these courses. We also wondered if the administrative experience gained by the Secretary, John Furness, and his wife Beryl, in setting up these courses for the IHE could be carried over and adapted at Falfield.

In the event all our fears proved completely groundless. The 1976 courses were as strenuous, instructive, industrious and enjoyable as when held at Keele University, as the following extracts from reports indicate:

"Mr. — has arrived back stimulated and enthusiastic and full of praise for the Course, its content and the way it was run".

". . . everybody was involved to the maximum extent possible".

"In general the objectives were achieved whereby we were shown the way to improve our ability to manage. The pace of the course was sustained and the general feeling that Monday afternoon felt like Thursday morning gives an indication of personal involvement and the intensity of the work".

". . . the Course organisers were aware of the need to integrate the building and the engineering expertise and were successful in this attempt".

As the advertisements would say, just a few of the unsolicited testimonials. A closer look at the details of the 1976 Courses will perhaps reveal some of the reasons for the enthusiasm.

Each of the courses had a full attendance of over 60, including 14 to 18 from the building side of the Works Organisation. It was indeed pleasant to see these two professions working together in complete harmony. This integration of engineers and builders enabled each to learn, not only about their own managerial problems, but also those of their opposite number. To the surprise of many, the problems were found, in the main, to be common to both professions.

Good food, comfortable accommodation and good treatment by the staff are accepted without comment at Falfield. Unlike Keele University, it is our own establishment with a sense of intimacy. This was accentuated by the fact of having the whole Centre to ourselves for the week, which undoubtedly helped generate a strong feeling of comradeship and commitment to the courses.

The two 'Tournament Groups' designed, organised and supervised excellent knock-out competitions in a very short time, for the Monday evenings. Both competitions embraced such games as billiards, table-tennis, a tug-of-war, putting, and finished up with a social evening. The exercise in organisation brought out many lessons in management, which were the subject of a report and discussions at the end of both courses. It should be appreciated that the tournaments also provided a means of mixing the course members in a relaxed atmosphere after a gruelling first day of hard work.

The debates on Wednesday evenings were highly entertaining and

A lighter moment. Ken Eatwell recovers his trumpet from John Clark. The author referees, while Charles King waits patiently.

instructive and were a credit to both 'Debate Groups' who arranged them. We are sure that they were enjoyed by all. Both had their humorous moments. In June Ken Eatwell (RE to SW Thames RHA) one of the guest speakers, made his debating point with the aid of a trumpet, while in September some very odd types got into the act. The oratory in both debates was of a very high level and reflected the expert coaching of George Tuson.

The projects which take the form of an end of course exercise, were again included in both courses. In June the project related to 'Health and Safety at Falfield' and in September to 'Time Management'. Both projects were up to the usual standard and were well organised and run by the 'Project Groups'.

We cannot praise the arrangements for the course dinners too highly. Both dinners were held in the Centre Lounge, where the Falfield staff had gone to great lengths to make things look really impressive for the occasions. This helped to create the dignified atmosphere necessary for a dinner. The menu was excellent and we felt that Falfield had indeed accepted the Keele Courses. For what it's worth, the arrangements outshone many of the course dinners at Keele. It was unfortunate that Dr. Murray (DHSS), was unable to attend due to important and urgent business elsewhere, particularly after he had put so much into the course. We sincerely hope he will be with us in 1977.

Many of the contacts and links with Keele and the IHE were retained. Mr. Furness was present some of the time; the President (Mr. Howorth) attended both courses, speaking at the dinners and taking an active part in the sessions; two Past Presidents (Mr. Rooley and Mr. Manser) also took part; the Chairman of the Education Committee (Mr. Hermon) opened the September course, and the 1974 Keele Challenge Cup was presented to the winning groups in the tournaments.

Other VIPs who visited one or other of the courses included the Chief Engineer, now Chief Works Officer (Mr. Bolton), two Regional Works Officers (Mr. Constable and Mr. Winning), three Regional Engineers (Mr. Johnson, Mr. Eatwell and Mr. Flanigan, who opened the June course), two Regional Training Officers (Mr. R. Gourlay and Mr. A. N. Johnson), and one DHSS Architect (Mr. J. D. Twells).

In the main, the course programme and content appeared to have been pitched about right. There were weak spots of course, but these we hope will be ironed out for 1977. Although the Lecture Room was small for the number of course members the inconvenience was readily accepted by everybody. The staff at Falfield had gone to considerable trouble to prepare the lecture room for the Keele Course and this was indeed appreciated, truth to tell we had not anticipated such a good attendance. The New Assembly Hall will be ready for 1977, which should make for all-round improvement. The six Study Rooms where groups work on their exercises and discussions are an improvement.

Intermediate Course 1977: the Tutors (above), and a discussion group (below). Everyone certainly looks to be enjoying himself.

The 1977 Courses

Both the 1977 programmes are now in course of preparation, and in general they will retain the arrangement and content as for 1976. The courses will, however, be amended and updated to give them freshness and to take account of changing conditions. The aim will be to avoid any unnecessary repetition, so that individuals who have attended previous courses will obtain as great a benefit as those attending for the first time.

The objectives for the two courses are summed up in their titles:

'Developing management effectiveness'

With the inclusion of members from the whole of the Works Organisation, we must now cater for the wider catchment by broadening the design and content of the course programmes.

The programme content for both courses will be formed around various modified and updated exercises and projects connected with management, administration, human relationships etc. relative to the Works Organisation. These include:

Communications;
Reporting;
Verbal Skills;
Team Work;
Committee Working;
Organisation and Administration;
Presentation;
Behaviour Problems and Patterns;
Leadership;
Problem Solving.

Apart from the subjects dealt with as specific items in various sessions, the programme is designed to develop the more intangible aspects of management such as co-operation with others, team working and team spirit, initiative and drive, consideration and valuation of the other point of view etc.

The advanced course recognises the more senior level and greater experience of course members and the levels of the exercises and discussions are pitched accordingly.

The grading of officers for the two courses is arranged with a suitable overlap at Hospital Engineer level, but it should be appreciated that within a course all members are treated as equal, irrespective of their grade or position in the service.

Broadly speaking, the courses are split into the following categories:

Intermediate Course (K3) July 10-15

Assistant Engineers and Building Officers;
Foremen with a potential for promotion;
Newly-appointed Hospital Engineers and 'Third-in-Line Works Staff;
RHA Works Staff up to and including TA I.

Advanced Course (K4) September 18-23

Area and District Works Officers;
'Third-in-Line' Works Staff at Area and District;
Experienced Hospital Engineers and Building Officers;
RHA Works Staff of Main Grade Level and above.

A very limited number of places will be reserved for staff of consulting engineers, architects working on Health Service schemes, or overseas staff connected with hospitals.

Course fee

The course fee for members within the National Health Service is £80 which includes meals and accommodation. For those outside the Service the cost is £160 inclusive.

Nominations and enquiries should be made to the Principal, Hospital Engineering Centre, Eastwood Park, Falfield, Wotton-under-Edge, Gloucestershire GL12 8DA. Telephone: 045-48 207.

For the past six years the health authority of South Glamorgan has co-operated with the Glamorgan Polytechnic in taking students on the Higher National Diploma Course for approximately five months' secondment on Industrial Training each year.

The author produced the following report after his secondment during 1976. It gives an interesting picture of the value of such practical experience to college-based students.

A Student's View of Industrial Training

RICHARD J. DUTKOWSKI

Introduction

The Engineering Project Section is an integral part of the Area Works Department of the South Glamorgan Health Authority. The work undertaken by the Section varies considerably from Electrical to Mechanical work. The design work carried out deals with all the varied Hospital requirements in the South Glamorgan area, from water and heating supplies to electrical power, lighting, fire detection and fire protection.

Close communications are maintained between the Project Engineer and all the Hospital Engineers, as well as the Area Planning Department, so that all the new work undertaken is done both efficiently and effectively.

Summary

The projects undertaken during my Industrial Training period with the Engineering Project Section were as follows:

a. to design a new Power and Lighting layout for Wards 4 and 5 at Rookwood Hospital;
b. to design a new Lighting layout

for the proposed extension to the Bookshop at the University Hospital of Wales;
c. to design a layout for the new equipment for the Servery at Ely Hospital;
d. the resiting and modification of the existing stand-by generator at St. David's Hospital;
e. several sets of drawings for various other projects were also made.
A detailed report of the training period follows.

Industrial Training Report

The training programme started with several site visits to Rookwood Hospital to look at Wards 4 and 5 to discuss ideas with the Hospital Engineer, regarding the upgrading of these two wards. After deciding with the Engineer the basic layout of new power and lighting circuits, two preliminary drawings were made at the Project Office. Several existing drawings of the hospital wards were referred to, to attain the format, symbols and scaling etc., of the drawings to be made. The positions of all the power socket outlets, connection units, lights and switches were plotted on this new drawing, and account was also taken of the trunking runs and new Nurse Call System to be installed.

On completion, the drawings were taken back to the Hospital Engineer for approval and discussion. Several slight adjustments were made and my proposed suggestions for extra lighting in the toilet block and corridor were approved by the Engineer.

The approximate positions of the ward beds were determined so that the bed-head units could be included on the plans. A final drawing of the Power layout was made, but completion of the Lighting layout was delayed for some time, since a final decision as to the type of ward lighting had not been reached at that time. An interview with a Lighting representative was arranged to discuss the most economical means of illumination for the ward areas, whilst still maintaining the stringent controls imposed on the layout of ward lighting systems.

A schematic plan of the new trunking layout was then drawn to help with the contract specifications. After referring to several Electrical manufacturers' catalogues available at the Project Office, an initial electrical specification was written for the work to be carried out at Rookwood Hospital. When this had been completed a further meeting with the Hospital Engineer was arranged and the draft specification was discussed in detail. Since the scheme involved two separate ward areas, which were connected by a corridor, it was agreed to duplicate the Power and Lighting layouts of both wards as far as possible. However, one of the wards was completely empty, which made access very easy, whereas access to the other ward was more restricted, since it was being used to its fullest capacity. This meant that times had to be arranged with the Ward Sister when it was convenient to measure up for the lighting positions and trunking runs. The layouts for Ward 5 were completed initially, and then repeated for Ward 4, making the slight modifications necessary.

A survey of the existing electrical fittings in each room was carried out with the Hospital Engineer, and in some instances it was decided to reuse the existing fittings in some of the low priority rooms, such as the corridor and laundry rooms.

After meeting the Lighting Engineer and discussing with him the necessary requirements as regards Hospital Ward lighting, a particular fluorescent fitting was recommended. This type of fitting had been especially designed to minimise glare and discomfort to patients in bed.

When these fittings had been included in the draft specification, the lighting drawings were then completed and work on completing the electrical specification continued. Schedules of cables, switchgear, installation accessories, lighting fittings etc., were made, making reference to the catalogues available at the office, to obtain the relevant list numbers of the equipment to be used.

Since both Wards 4 and 5 were supplied by three-phase power, phasing of the wards had to be carried out. This involved distributing the electrical loading of both wards equally on the three phases so as to maintain an approximately balanced power supply at the Hospital. This phasing took a considerable time, because it was very difficult to find the most suitable arrangement, both the Project Engineer and the Hospital Engineer gave me help and advice with this part of the work. A careful check was made to ensure safety in the positioning of the electrical fittings, especially equipment that was to be supplied from a different phase to that adjacent to it. Since the potential difference between any two phases is 415 volts, safety in this respect is of primary importance. After completing the phasing layout and the calculations of the loading on the individual circuits, approval was obtained from the Hospital Engineer in that the proposed plans and specification were satisfactory.

A block schematic diagram of the switchfuses and the distribution board was drawn up to aid with the description of the Power layout. The completed draft copy of the specification was then sent off to be rough-typed prior to being typed onto stencils. After checking the rough-typed copy for errors, it was then laid out correctly and typed onto stencils for duplication.

Site visits were arranged so that Contractors could have first hand knowledge of the work to be done. After all the tenders had been returned, the most suitable was selected.

A pre-contract meeting was set to discuss the contract details with the Hospital Engineer, the Project Engineer and a member of the Area Planning Department together with myself. The contract was due to be finished in approximately 11 weeks.

Lighting Layout for the New Extension to the Bookshop at the University Hospital of Wales

The second project that was undertaken was the alteration of the existing lighting in the Bookshop at the Heath Hospital. A preliminary site visit was made to the Bookshop to note the positions of the existing lighting and to find their switching positions. An electrical drawing of the area in question was obtained from the Hospital Engineer and the fixture positions marked on the drawing were compared to their actual positions. A new drawing of the Bookshop area was then made, together with the new extension. The existing lighting positions were plotted onto this drawing.

It had been noted that the existing lighting positions and the fittings were totally inadequate for the use to which they had been put, and it was decided to investigate the possibility of using a different lighting layout and more efficient fittings. The existing fittings were of a cylindrical type suspended vertically, each having a 150 watt lamp. These fittings only produced a pool of light vertically below them, and were not at all sufficient to illuminate bookshelves and displays.

After looking through lighting catalogues illustrating different fittings, an appointment was made to see a lighting Engineer. During discussions with him and examination of the Bookshop drawings, it was suggested that a system of spotlights should be used. These spotlights were to be connected to lengths of track along which fittings can be moved and adjusted without the use of cables. Several different types of spotlight were examined and a particular type recommended for the specific use to which it was to be put. The photometric data gave the average illumination at various distances from the fitting. This data was later used to design a system to illuminate the Bookshop area, bookshelves and counters as efficiently as possible. To do this, a cross-sectional plan of the Bookshop was drawn and card cut outs were made to the shape of the light spread of the fittings. These card cut outs enabled the best position for the fittings to be located. A position of 4ft from the bookshelves was found to be the best, since the height of the ceiling was approximately 10ft.

This ensured that the person standing in front of the bookshelves would not cast too much shadow on the books he was looking at. Using all this information, a drawing was then made of the new lighting layout for the Bookshop.

Rookwood — Calorifiers

After the Bookshop Project had been completed and all the specification written, another project was begun. This project involved the measurement and plotting of the existing pipework for the calorifiers (i.e. Heat Exchangers) at Rookwood Hospital. As this was a mechanical project and my knowledge of calorifier systems and plant rooms was very limited, several technical papers and booklets were referred to, to gain a basic insight into the topic. A manufacturer's information sheet entitled Steam Heated Calorifiers was studied. It gave a general outline to the construction and operation of a calorifier illustrating the characteristics, thermostatic control, effective pressure, sizing the control valve and details on handling the condensate.

Although the information was quite basic, it proved to be invaluable when the pipe layouts were being plotted, since identification of Steam, Condensate and Heating pipes became easier. Later a selection of Information sheets was also studied, the topics covered ranged from information on Boiler House layout, and operation, steam distribution, condensate rates, condensate recovery and compressed air, to mention but a few.

Since a basic knowledge of these subjects had not been covered by my college course, I decided to undertake a home correspondence course, initially starting with a Preliminary course and later progressing to more advanced work. The simplified scheme consists of ten folios covering the most essential details of steam utilisation and heat transfer. The advanced scheme consists of two specialist courses and a primary section common to both. The folios are sent out at monthly intervals.

After being familiarised with general Calorifier and Plant Room layouts, several site visits were made to sketch and measure the calorifiers and the associated pipework in all the Plant Rooms at the Hospital. In total, six drawings were made, one for each calorifier, but each drawing had three parts to it; a layout of the steam pipes, a layout of the heating pipes and finally a layout of the condensate pipes. These were split up in this way in order to make viewing easier of the particular runs, rather than having all three types of pipework on the same drawing. This would have been very cluttered and also difficult to read. After the sketches had been completed, accurate orthographical drawings were made of these, to scale. A return site visit was made, and the new calorifiers that were to replace the existing ones were measured up.

Final arrangements for the replacement of these existing Calorifiers have not as yet been completed.

Servery — Ely Hospital

A new project was begun which was to design a layout of new equipment in the proposed extension to the servery at Ely Hospital. Initially a survey was made and the existing servery measured and the type, size and position of the existing equipment. Details of the new equipment, i.e. new sink unit, dishwasher and waste food disposer were taken so that a layout could be designed for this equipment. A scaled drawing was then made at the office, and various equipment layouts tried. It was then proposed that the new equipment should be installed in the present servery and that the proposed extension should not be included in the plant. The most suitable layout was then obtained and a specification for the work to be done was written out.

Lecture on Hospital Sanitation and Drainage

On July 29, a lecture was given at the University Hospital of Wales on Hospital Sanitation and Drainage, by a Consultant Engineer. The lecture outlined the importance of good design in Hospital drainage systems, and illustrated the difficulties caused by bad design, resulting in blockages etc. The lecture also indicated specific problems caused by the different materials that are used in drainage systems, e.g. cast iron pipes are inherently bad for causing blockages because the inner surfaces of the pipes are very rough, so that large particles become caught to the pipe sides. This happens especially at bends. It has been found from experience, that bends at 130° produce less blockages than those at 90°.

The difficulties and limitations of plastic pipes were also discussed in some detail.

The Engineer stated that approximately 40% of all hospital waste is of the domestic type, 20% is of the office type and the remaining 40% was the most destructive type, i.e. chemicals, bleaches and cleaning fluids.

The importance of site supervision during the building stage was stressed as many design problems and contractor's carelessness could be overcome at this stage and hence reduce the number of blockages that occur.

Planned Preventive Maintenance

During my training period a visit was made to the PPM (Planned Preventive Maintenance) Department to gain an insight into the techniques used to plan the maintenance schedules for all the hospitals within the South Glamorgan area.

The Department uses an advanced system, employing a Farrington Data Processing machine. The PPM Engineer described the system in detail, starting with the Field Survey Books which are filled when preventive maintenance is being planned for a particular unit, i.e. a boiler house, ward or kitchen. There are two field survey books, electrical and mechanical. These contain a list of all the equipment usually found in the above Departments. During the initial survey all items within the unit in question are catalogued into the books prior to being categorised and stored for the processing machine. A sample copy of a Field Survey Book can be seen at the rear of the Log Book, together with a copy of the instruction book for the Farrington Data Processing machine.

The categorised data from the field surveys is punched onto metal plates and filed. All the relevant maintenance details are punched onto these plates, together with the frequency at which they are to be done. Since maintenance schedules have to be prepared every week for each hospital, the relevant files of plates are fed into the machine, which then either prints or rejects the appropriate plates for the area in question. In this way, sheets of maintenance instructions are produced which are then distributed to the hospitals etc.

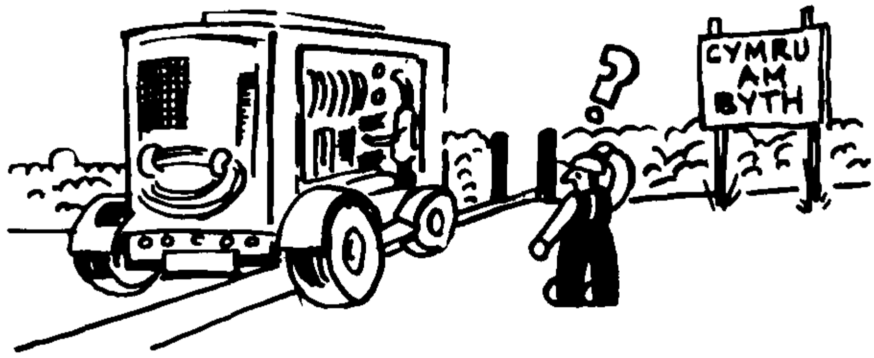
The instruction book indicates the method by which the information is updated. The PPM Engineer also has the task of preparing a chart tabulating the maintenance work load of a Hospital distributed evenly throughout the year.

The basic knowledge gained of Planned Maintenance was useful in understanding the general maintenance problems of a hospital, and also an insight into the types of problems that a Hospital Engineer has to deal with.

Generator — St. David's

The standby generator situated at St. David's Hospital in Cardiff, was to be resited and then modified slightly, so that on a break in the supply it would automatically switch in to the mains. At present, the switch over has to be done manually.

A meeting with the Hospital Engineer of St. David's was arranged, and details of the past work on this project were handed over to me. The existing position of the generator was pointed out to me by the Engineer, and the possible new site indicated. After discussing details of the job, a survey of the possible site was made. Special attention was paid to the position of drainage pipes and man-hole covers, as these would limit the position of the generator. Upon measuring the dimensions of the generator itself, it became evident that it was in fact possible to use the proposed site, but certain practical difficulties may be experienced, especially in manoeuvring the generator through the narrow gateway into the proposed site.



. . . certain practical difficulties may be experienced . . .

Scaled drawings were made at the office of the layout of the site and also of the original position of the generator with respect to it. A schematic layout of the alterations to the Busbar chamber was also made.

An appointment was made with the Branch Manager of a Heavy Haulage company, to come to the Hospital and to discuss the practical difficulties that may be experienced in resiting the generator, and in fact if it was at all possible. After discussing with him the proposals, he examined the site and decided that it was possible to manoeuvre the generator, although specialised equipment would be required. The work involved would probably take a whole day, and it would probably have to be undertaken at a weekend, so as to reduce the inconvenience caused to the Hospital and to the Ambulance Service.

Drawings of the site were sent to the generator's manufacturers, who requested drawings to help them assess the electrical work involved in modifying and connecting the generator to the Hospital Switch Room.

Conclusions

The training programme proved to be very challenging because the work set for me was both productive and interesting, rather than just a set of exercises. I found that the training was most beneficial, since the responsibility given to me encouraged me to do the work to the best of my ability, since I felt I was being useful rather than getting in the way.

The projects that were undertaken were very varied, in that they involved site visits, surveys, contract meetings, discussions with Engineers as well as Drawing Office practice. The experience gained was very useful especially since it gave me an outline to general engineering work, which is something that cannot be gained at College.

I also found that the training greatly enhanced the academic work I have undertaken at College. Topics such as electrical phasing, i.e. the distribution of electrical loading on a three-phase system had not been studied at College in depth, but had to be tackled as an important part of a project I undertook. A certain amount of background reading had to be done on the subject, so that the project could be completed.

Several of the projects were of a mechanical nature. I found that undertaking these was very useful in that it gave me a broader insight into Engineering.

I have found that a good Engineer should have a working knowledge, not only of his own particular field, but also of associated fields, as well as totally different branches of Engineering. This gives the Engineer a great advantage in his work, since he will be able to foresee many of the problems that may arise with his work. Engineers who only concentrate on their particular field of work, be it electrical, mechanical or any other, will no doubt become very narrow-minded in their outlook on a specific problem.

In conclusion, I found that the training programme was very good, and I found it a great benefit to myself. The amount of supervision that a student Engineer requires, obviously depends entirely on the individual. I found that the Project Engineer was very understanding, and always willing to advise me when I came across particular difficulties. I am unable to criticise the training programme in any way, indeed, I found it thoroughly enjoyable.

Product News

SampleLink

For laboratories and hospitals, the SampleLink range of airtube systems provides a fast, robust and secure form of test sample handling. Carriers are propelled at up to 23 metres per second (50 mph).

The range consists of point-to-point systems using a single or double tube (to return empty carriers) and a series of single line automatic systems linking up to 25 stations with the central laboratory.

Tube sizes range from 55 mm to 125 mm in diameter and tubing may be in PVC or steel — or both in one system — depending on the environmental conditions in which it is installed.

Carriers are available in a wide range of designs. Delicate hospital specimens, blood and drugs can be carried in well protected glass containers inside the carriers and, at the other extreme white hot steel can be carried in insulated carriers which can be handled without protective gloves. In between these come carriers for such awkward to handle items as radioactive materials, acids, dusty powders and so on.

A new feature is the 75 mm system which does not necessarily need its own air-blower supply — it can be run off the works compressed air system.

Further information: *D. D. Lamson Ltd., Gosport, Hants.*

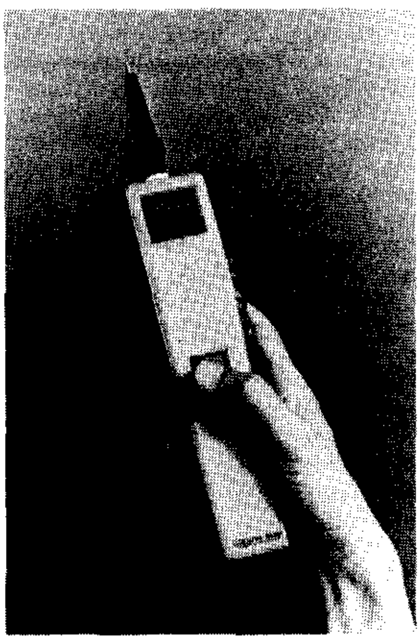
New British Multimeter

A new digital multimeter (for measuring AC and DC volts/amps/ohms/ and continuity) has been introduced for both field service and laboratory use by Kane-May Limited of Welwyn Garden City.

Called the 'Digimeter', this new electronic testing device is not just portable but is housed entirely in the handle of a probe unit. It is thus designed for single hand operation. The digital display is located in the head of the probe handle.

Despite its small size and light weight, 'Digimeter' offers a measuring capability normally associated with full size instruments. For example, it will measure 2V to 1000V DC with an accuracy of ± 0.6% or from 2 to 2000K with an accuracy of typically 1% and auto ranging is operative on all relevant functions. Additionally, there are separate 200mV fixed span, high sensitivity, voltage ranges. 'Digimeter' embodies automatic polarity indication and can be operated by mains or internal battery. For the latter, there is a simple, plug-in, battery recharging facility. It is thought that the new instrument, because of its comprehensive facilities and consequent simplicity of operation, will prove equally suitable for laboratory and development work and for service applications of all types.

Kane-May's 'Digimeter'.



The instrument, which is made by Kane-May Limited in Welwyn Garden City, follows the range of Dependatherm and Digitherm electronic thermometers which are now widely used in process industries throughout the world.

Further information: *Kane-May Limited, Burrowfield, Welwyn Garden City, Herts. Tel. (07073) 31051.*

Sterilisation of hospital ducting

The trunking of closed air conditioning systems in hospitals under construction or undergoing alteration needs to be rendered sterile and other ducting in hospitals may need periodic cleaning.

A sterilising system has been devised by Rentokil's fumigation service to treat such ducts and trunking using vaporised formaldehyde.

It has been used successfully in a number of hospitals and can be supplemented by sluicing down and disinfecting of other areas if required.

Rentokil offer the service as subcontractors to heating and ventilating engineers or direct to hospital authorities.

Further information: *Rentokil Limited, Marine and Fumigation, 11 Court Road, Frampton Cotterell, Bristol BS17 2DE.*

Export Assistance by COI

In the highly competitive export market favourable publicity in target countries can influence purchasing decisions by overseas governments, organisations and individual businessmen. The Central Office of Information provides a free service of export publicity across all sectors of British industry, and a wide range of material on British expertise in the medical field forms a substantial part of the effort conducted in all media.

The official information service is operated by the Foreign and Commonwealth Office through its diplomatic missions abroad in collaboration with the British Overseas Trade Board. The Central Office of Information provides the material which is fed by diplomatic posts to the local media.

The objective is to support Britain's position as a nation which depends on exports by convincing opinion abroad that this country is a stable, skilful, forward - looking, technologically - advanced industrial nation, and a sound trading partner.

The aim is to demonstrate, by specific case history examples, that Britain has the creative ideas and the skills, backed by research and development of a high technological order, to produce the goods and services which the foreign consumer will wish to buy.

Because newsworthiness is the key to usage the service concentrates on the new or improved product, process or services: in other words, both the hardware of the discipline and the design concepts and skills of the architects, engineers and consultants whose professional expertise puts the stamp of quality on British output.

If the medical industry produces a highly advanced piece of equipment, then the COI can help to publicise this worldwide. The EMI body and brain scanners are a recent example. The COI may also be able to help to publicise abroad, in those areas where there is a likely demand, the consultant skills which go into planning such things as public health systems. One documentary film on fully equipped hospital packages has been translated by the COI into ten languages and shown in North and South America, Africa, the Far East, Middle East and Europe.

The daily flow of press stories and features, black and white and colour photographs, television, radio and film material, is backed by a Reference service, which covers all key aspects of Britain, including health services, and medical advancements in Britain.

For businessmen going overseas to sell their goods there is a special service. The COI does all the publicity support for the BOTB-sponsored joint ventures and outward trade missions. A lot of support is given in these two fields to medically orientated British selling teams.

The COI can only do its job effectively if it is kept informed by industry itself. If you have a good story to tell in the export sense, then the COI will use it. How it will do so will depend of course on the nature of the story and the available outlets in target countries. So make a point of letting the COI know, either through its London headquarters, or its nine regional offices in England, or through the Information Divisions of the Northern Ireland, Scottish and Welsh Offices.

Students' pages

Mr. Fletcher is Area Engineer, Cleveland Area Health Authority. This paper represents the first of a number of articles which will be published in Hospital Engineering, *specifically for new entrants to the field.*

In his own area Mr. Fletcher has introduced a series of bi-monthly lectures in which specific engineering topics are explained and discussed. The lectures are basically aimed at levels up to and including hospital engineers, and have proved popular with engineering staff within the area.

Mr. Fletcher's enterprise in setting up these lectures is to be applauded — the Editor will be pleased to hear of other such schemes, and to receive any papers produced.

Boiler and Feed Water Treatment

J. R. FLETCHER BA CEng MIMechE MIMarE AMBIM FIHospE

Until about ten years ago the majority of new entrants in hospital engineering had previously been marine engineers, whereby they had received some training in the control and supervision of boiler water treatment as used in shell and water tube boilers. The water used had invariably been evaporated from sea water, with its associated possibilities of contamination. Therefore great care had to be exercised in the testing and treatment of boiler and feed waters.

Marine engineers entering the hospital service experienced very little trouble in adapting to and maintaining the requirements of water treatment for the type of low pressure shell boilers invariably used in the hospital service (maximum pressure usually 150 psig, approximately 10 bar).

The continuing growth in technology and the introduction of sophisticated equipment, particularly in the electro-medical field, into the hospital service has inevitably led to a demand for engineers with higher academic qualifications. This has seen the supply of 'steam' engineers being replaced by new entrants from industry, who although having the necessary theoretical knowledge, have invariably not had any previous experience of steam raising plant.

The control of boiler and feed water is usually a new experience to these entrants. This lack of experience should be rectified by adequate 'in-house' training. Unfortunately, due to the work load of more senior staff, this is not often possible.

It is hoped that this paper will compensate in some small way for previous lack of training, and provide some basic knowledge and facts as to how and why water treatment is considered necessary.

It should be appreciated that the treatment of boiler and feed water is constantly improving, and whilst the actual treatment used in hospitals is often dependant upon the chemical company supplying the chemicals, fundamentally the basics are similar.

It could be argued that the boiler plant is possibly the most important single piece of engineering equipment within a hospital. If it fails chaos quickly results, with its subsequent effect on patient care. Therefore, the importance of good boiler water treatment cannot be over-emphasised. Without the use of water treatment boiler plant would rapidly deteriorate and eventually cease to function, due to corrosion attacks, scale build-up on heat transfer surfaces, and tube failures. Concentrated dissolved solids would lead to priming and foaming, with the subsequent contamination of the distribution pipework, etc.

It is not intended that this paper should be a lecture on chemical engineering. Therefore chemical formulae are avoided where possible. It is hoped that the lecture will encourage new entrants to take an active interest in water treatment and so carry out further study on this very important subject.

Although it may not be thought necessary for hospital engineers to remember chemical formulae, they should be familiar with the chemicals they are using, and what functions they perform when added to boiler and feed waters.

Water treatment

This is a general term applicable to an inexhaustible host of processes, ranging from the simplest form of natural sedimentation to the most complex procedures employing passage through ion exchange resins, fractional vacuum distillation and treatment with chemicals. The type of treatment chosen in any particular case depends primarily upon the nature of the raw water, the use to which the water is to be put and upon the type and concentration of residual impurity which can be tolerated.

A domestic or low pressure industrial boiler may be fed with a soft water containing up to 1000 ppm sodium chloride and not show any serious deterioration after ten years of use, whereas a content of 3 ppm of sodium chloride could be considered high for a high pressure water tube boiler. Ideally the purer the water the less likely it is to cause corrosion. Unfortunately, engineers must be guided by economic as well as by technical considerations, and for this reason it is common practice to limit water treatment to processes which experience shows to be absolutely essential. It is a scientific statement of fact that most forms of chemical corrosion proceed more rapidly at higher temperatures. Were it not for the formation of non-reactive compounds or scales, the life of a boiler tube operating at high temperature (900°F) with impure water could be counted in weeks rather than years.

The parts of a feed system with which we are concerned are made of steel, copper alloys, and nickel alloys. The latter two materials figure only in special components, and steel represents our basic material of construction. The aggressive agent with which we are concerned is water and its impurities, both solid and gaseous, which it contains in various measures. Even pure water, as well as raw water reacts with steel at the temperatures common in boiler and feed water systems. Therefore it is evident that our task is not one of preventing corrosion, for that is not possible, but rather one of limiting corrosion to an acceptable rate.

Corrosion

Corrosion can be defined as occurring when the state of a material is chemically so altered that its continued ability to perform the function expected of it is impaired. In the light of such a definition, the formation of a thin impenetrable protective coating could be considered as not being a process of corrosion. However, the progressive establishment of a coating of sufficient thickness to adversely affect the thermal properties of a heat transfer component, resulting in the loss of efficiency and destructive fireside overheating, could be viewed as a process of corrosion, even if the coating remains impenetrable and protective.

Therefore it is evident that a given method of water treatment may produce desirable results from one point of view, and highly undesirable results when viewed from another.

Boiler water treatment will usually consist of a combination of the following chemicals.

Multi-duty treatment
Liquid tannin based treatments. Protects against scale formation and corrosion. Simple to dose and control.

Alkalinity adjustment
Blended alkalis added to adjust the levels of alkalinity in the water.

Hardness conditioner
Powdered phosphates added for precipitation of hardness and prevention of scale within boilers.

Sludge conditioner
Liquid polymers for conditioning sludges so that they are mobile and removable by blowdown.

Oxygen scavenger
a. Catalysed powdered sodium sulphite ensures rapid reaction with oxygen;
b. Liquid hydrazine oxygen scavenger, usually used on high pressure boilers.

Condensate conditioning
a. Liquid neutralising amine for the prevention of corrosion. Neutralises carbon dioxide and renders condensate alkali;
b. Liquid filming amine for the prevention of corrosion. Forms surface film, thus preventing contact of pipework, etc., with acidic condensate. For restrictions of use see HTM 6.

Foam suppression
Liquid antifoam added for the prevention of priming and carry over caused by high dissolved solids within the boiler water.

Some definitions used in boiler water analysis, testing and treatment

Acidity/Alkalinity
All liquids of which water (H.OH) forms a part contain free hydrogen (H) ions and free hydroxyl (OH) ions. When these ions are exactly balanced the liquid is neutral. An *acidic* solution indicates an *excess of hydrogen (H) ions* and an *alkaline* solution constitutes an *excess of hydroxyl (OH) ions*.

Coagulant
A chemical substance which attracts fine particles floating in a liquid. In boiler water coagulants cause fine solids to settle as soft sludges that may be removed by blowdown.

Hardness
A term used to indicate that a water contains substances which destroy soap lather, most of these substances being compounds of calcium and magnesium.

Indicator
A solution which exhibits a change in its colour when a small quantity is

dissolved in a water sample whose acidity or alkalinity is within a known and stipulated range. They are all organic compounds with complex chemical formulae and are themselves weak-acids or alkalis. The colour change is their special characteristic which results from ionisation and not chemical reaction.

Reagent
A substance which, because of its known chemical properties, is used to produce specific reactions with particular constituents of water which it is desired to measure. The reaction is observed, and the quantity of the reagent required to produce it is recorded, so that a calculation can be made as to the quantity of the constituent being measured. Thus a reagent serves as a measuring instrument.

Precipitate
The insoluble solid which may be formed by the reaction between solutions of two soluble substances.

Free carbon dioxide
The CO_2 in the water excluding that contained in the carbonate and bicarbonates. High quantities of free CO_2 may be responsible for corrosion of steam and condense lines.

Carbonate hardness
Represents the bicarbonate of calcium, magnesium and iron which precipitate out of solution as solids below 100°C by the driving off of CO_2.

Non-carbonate hardness
May mean anything that destroys soap and is not removed by boiling water. All sulphates or chlorides of calcium, magnesium and iron come under this heading, although calcium sulphate comes out of solution more easily than the remainder.

Temporary hardness
Is due to calcium bicarbonates which break down on boiling with precipitation of calcium carbonate and liberation of CO_2. Precipitation is heaviest at heated surfaces, therefore it is in these areas that scale formation is prevalent.

Permanent hardness
Is due to calcium sulphate which only precipitates when concentrated beyond its solubility. As solubility decreases with increasing temperature it also forms scale on heated surfaces.

Total dissolved solids
Represents the solids in solution, invisible and unfilterable.

Suspended solids
Represents visible or filterable solids.

Foaming or carry-over
The following are common causes of this problem, either singly or in combination.
a. Excessive total dissolved solids;
b. Excessive and sudden demands for steam, leading to pressure drop;
c. Excessive low surface tension in the boiler causing the steam to emerge in very small bubbles or foam formation;
d. Oil;
e. Detergent;
f. Very high boiler water level.
An antifoam can be added to prevent priming and foaming caused, which breaks down the foam bubbles. Although not always effective they are worth trying.

Scaling
Is caused primarily by calcium and magnesium bearing salts, almost all raw water contains potential scale forming salts. The least soluble salts and most common cause of scale formation are calcium carbonate and calcium sulphate. Of these two, calcium carbonate is the main problem. The build-up of scale acts as an insulator which can seriously affect heat transfer performance.

Purpose of and reactions during testing

Total dissolved solid content
Measures the influx of scale forming and corrosive mineral salts with the feed water. It includes all salts whether they are considered desirable, undesirable or neutral.

Hardness
Hardness in water is due to the presence, in solution, of calcium and magnesium salts, which, under boiler conditions, form scale. Since hardness exhibits itself by the non-formation of a permanent lather when mixed with soap solution, the intensity of hardness of boiler water measures the inclination of the water to form scales on heating surfaces.

Alkalinity
Simply stated, an alkaline solution is one which contains hydroxides, carbonates and/or bicarbonates.

Alkalinity

a. *Phenolphthalein alkalinity*
This measures alkalinity due to hydroxides or carbonates, but excludes bicarbonates. When a drop of phenol indicator (itself an alkaline liquid) is added to water containing hydroxides or carbonates it turns pink, indicating that the alkalinity of the solution is greater than that of the phenol drop. When acid is added to neutralise the alkalinity the pink colour is discharged. At this instant of colour change all the hydroxides have been neutralised, all the carbonate molecules have been reformed into half their number of bicarbonate molecules, and all the tri-sodium phosphate molecules have been converted into one-third their number of sodium phosphate molecules.

b. *Caustic alkalinity*
This measures alkalinity due to hydroxides only. When barium chloride is added to an alkaline sample, the carbonates and phosphates are precipitated leaving only the hydroxide (or caustic) alkalis. A phenol test carried out after this elimination of the carbonates and phosphates will give a measure of the caustic alkalinity.

c. *Total alkalinity*
This measures the total quantity of all dissolved salts imparting alkalinity to the water. Phenol indicator will not turn pink in presence of bicarbonates since the alkalinity of the phenol drop is greater than that of the bicarbonate solution. Methylorange, however, reacts even in the presence of bicarbonates. If water is alkaline, a few drops of methylorange indicator turns the water yellow, and when the alkalinity is completely neutralised by an acid the colour changes red.

Chlorides
The presence of chlorides (sodium and magnesium) can only mean leakage of untreated water into plant. The chloride test determines the magnitude of this leakage.

In the presence of potassium chromate in water, silver nitrate reagent takes on a brick red colour due to the formation of silver chromate. Silver nitrate has a greater chemical affinity towards chlorides than for potassium chromate. Thus, when silver nitrate is added to slightly acidic water (essential for promoting active chemical reactions) containing chloride salts as well as potassium chromate, a colour change indicating the formation of silver chromate takes place only when the chloride salts have been acted upon.

Sulphites
Crystalline sodium sulphite has a great affinity for oxygen and combines with it to form sodium sulphate. This sodium sulphite is used as an oxygen scavenger, and a slight excess of sulphites in the boiler water would indicate an absence of oxygen. If starch solution is added to pure water, and the solution is then titrated with potassium iodide-iodate solution, a blue colour is instantly obtained. In the presence of sodium sulphite, the reaction between the iodide-iodate solution and the sodium sulphite occurs before the reaction between iodide-iodate solution and the starch. Thus, the blue colour will not be formed until all the sodium sulphite has been reacted upon.

Phosphates
Phosphates are used in boiler water treatment to maintain alkalinity, and to precipitate the calcium salts in the feed water as calcium phosphates, and thus prevent the formation of scale. It is thus essential to maintain an excess of sodium phosphate in the boiler water.

In the presence of sodium phosphate, water with potassium nitrate crystals dissolved in it reacts to the addition of ammonium molybdate by becoming cloudy. The larger the quantity of sodium phosphate present, the quicker this reaction. Thus the time taken for the onset of cloudiness is used as a measure of the excess phosphate content.

Effects of various salts in boilers, evaporators and other heat exchangers

Sodium chloride (common salt)
Is extremely soluble and stable and normally remains in solution in boiler water. Only starts precipitating when a density of about $^7/_{32}$ nd is reached; saturation reached at about $^{12}/_{32}$ nd.

Magnesium chloride
Precipitates and may chemically decompose at about 360°F (140 psig) or $^5/_{32}$ nd density, to form magnesium hydroxide and hydrochloric acid. This acid may react with the iron of the plates to form oxides of iron and to liberate free chlorine gas. The chlorine may then recombine with the magnesium hydroxide to re-form magnesium chloride, and the cycle is ready to be repeated. This results in corrosion occurring, out of all proportion to the original quantity of salt present. In addition, the practically insoluble magnesium hydroxide (the commonest magnesium compound found in boiler scale) may form a scale of moderate hardness.

Magnesium sulphate (Epsom salts)
Is a highly soluble salt, normally remaining in solution under boiler conditions. Under extreme conditions, however, it may decompose to form the scale forming magnesium hydroxide.

Calcium sulphate (gypsum of plaster of Paris)
Solubility decreases with temperature increase until saturation occurs at about 280°F (35 psig). Forms a very hard, close grained scale which adheres very strongly to the heating surfaces. It also acts, like cement, as a bonding agent, to build up composite scales of magnesium and calcium salts. Concentrations should be avoided by removing from solution with chemical reaction.

Calcium carbonate (insoluble chalk)
Calcium bicarbonate exists only in solution in the presence of CO_2. When heated to, and above, about 180°F, the calcium bicarbonate decomposes when CO_2 is driven off, and the insoluble calcium carbonate is precipitated to form a comparatively soft scale or sludge.

Silica
Under boiler conditions may form a very hard, heat resisting, strongly adherent scale, particularly in the presence of calcium and magnesium salts. Average heat transfer coefficient for silica and calcium sulphate scale between 0.5 and 1.5 Btu/ft^2/ft/°F/hr, but porosity may considerably reduce these figures.

Note:
The salts mentioned above may be precipitated at lower temperatures than those quoted if abnormally high densities are reached. Also, salts which are stable and remain in solution may not themselves cause corrosion or form scale, but by increasing the density they form electrolytes thereby promoting corrosion, and cause foaming and priming by reducing the surface tension of the water.

Effects of gases and oil entering a boiler

Oxygen
The presence of oxygen will result in serious corrosion, either by direct oxidation or by the creation of a galvanic cell. In the former case, general wastage of the boiler metal will result; in the latter, corrosive pitting will result. In both cases the severity of the resulting corrosion will be influenced by the quantity of oxygen present. Pitting is caused by the oxygen (or air bubble) adhering to the plate, thereby creating a galvanic cell and causing an electric current to flow which results in the evolution of hydrogen and wastage of the plate. Normally the hydrogen so evolved would diminish the cell effect by 'polarisation' but the oxygen present combines with the hydrogen to form water, thereby causing corrosion to proceed unchecked until all the oxygen is exhausted.

Carbon dioxide
This may be present in the feed as a dissolved gas, or in the form of carbonic acid (H_2CO_3). The presence of CO_2 in the feed water results in the lowering of the pH value and subsequent corrosion which may occur in the following manner. Iron in the presence of CO_2 and water may form iron carbonate; iron carbonate in the presence of oxygen and water may form iron hydroxide which will, in turn, form rust and CO_2. Thus the cause of the trouble, namely CO_2, is reformed and able to repeat the cycle.

Various methods have been advocated for the removal of CO_2 from feed water, or for its neutralisation. These include addition of ammonia, ammonia compounds, amines, caustic soda or removal by ion exchange.

The solids within make up water tend to form scale on the tube walls. The scale so formed may attain a thickness and compactness great enough to interfere seriously with the heat transfer efficiency. In general, this scale such as black oxide, has no adverse effect, since even in a perfectly clean boiler the heat transfer between tube and water takes place through a gas film having a far lower thermal efficiency than that of the oxide film. It is only when the scale becomes $^1/_{32}$ in or more in thickness that it begins to have an adverse effect on thermal transfer.

Carbon dioxide can exist in water in three forms:

a. chemically combined in the form of bicarbonates and carbonates;

b. as the free carbon dioxide needed to keep these in solution;

c. any excess.

It is the excess known as the 'aggressive' carbon dioxide which is responsible for corrosion of ferrous and non-ferrous metals. Although carbonic acid is a weak acid, it nevertheless provides ample hydrogen ion concentration to promote acid corrosion and as feed water consisting principally of condensate is an unbuffered solution, the pH value may be lowered appreciably by small amounts of CO_2. Conversely the presence of small amounts of alkaline salts of ammonia carried over with the steam will neutralise the acidity caused by CO_2.

Sodium carbonate, when added to feed water as part of boiler water treatment, is an important source of CO_2. The decomposition of this compound is evinced by the appearance of caustic alkalinity in the boiler water and by the acidity of the condensate.

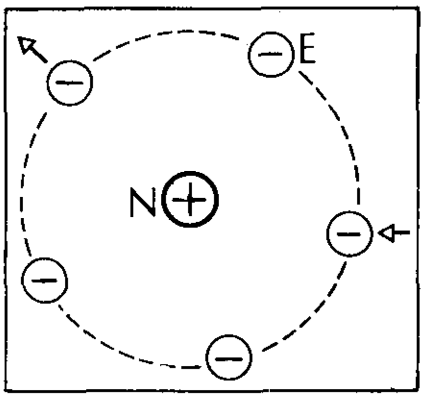
Another source of contamination is the make-up feed. Fresh water can contain appreciable amounts of calcium carbonate, and the resulting effluent may contain several ppm of CO_2. If the CO_2 content of make-up feed is to be materially reduced an ion exchange plant must be used, or the carbonic acid may be neutralised by chemical treatment. To safeguard plant from attack by aggressive condensate an alkalinity of between 8 to 9 pH should be maintained throughout the condensate feed system.

Oil

The presence of oil tends to promote the accumulation of scale, and to lower its heat transfer coefficient, thereby increasing the danger of overheating. In some cases oil may combine with hardness salts and rust to form oily balls which could so seriously reduce the flow of water in a tube as to cause overheating. Some animal and vegetable oils tend to decompose under boiler conditions to form fatty acids (eg Oleic, stearic) which would attack the boiler metal. Good grade mineral oils are more stable, but like all oils would cause overheating if allowed to deposit as a thin film on a heating surface.

Ionic theory

A normal atom has a heavy nucleus (N) with a + ve charge. Electrons (E) circling round it constitute the − ve charge. These charges are balanced and the atom, as a whole, is neutral. Under certain conditions an atom may attract an extra electron, or lose one. Then, equilibrium is upset and a resultant − ve or + ve charge is imparted to the atom.



An atom, or group of atoms, having a smaller or greater number of electrons than the normal compliment is known as an 'ion'.

An ion will thus have a − ve or + ve electrical charge, and when two galvanic elements of different electrical potentials are present, it will move towards one of them.

pH value and notation

In electrolysis, all liquids containing water show a tendency for a part of the water molecules to separate out into two kinds of ions, namely:

Hydrogen ions $(H)^+$
(1 electron short) and
Hydroxyl ions (OH)
(1 electron in excess)

When the number of $(H)^+$ and (OH) ions are equal, the solution is *neutral*. When there is an excess of $(H)^+$ ions, the solution is an *acid*: If the reverse is the case, it is an *alkali*.

A single $(OH)^-$ ion weighs 17 times the weight of a $(H)^+$ ion, but 1 gram-weight of $(H)^+$ ions and 17 gram-weight of $(OH)^-$ ions represent the same number of ions, the quantities in both cases being defined as 'one gram-ion'.

In 10,000,000 (ie 10^7) litres of pure water there is one gram-ion of $(H)^+$ ion and one gram-ion of $(OH)^-$ ions.

Thus, in 1 litre of pure water there are 10^{-7} gram-ions of $(H)^+$ ions and 10^{-7} gram-ions of $(OH)^-$ ions. The product of these $(H)^+$ and $(OH)^-$ ions is a constant for all solutions containing water, ie the product of 10^{-14} gram-ions per litre is a constant.

Addition of acids increases the $(H)^+$ ions and decreases the $(OH)^-$ ions. Additions of alkalis has the reverse effect, but in both cases, the products are still 10^{-14} each.

A water solution having a $(H)^+$ ion concentration of 10^{-7} is said to be *neutral*. If the $(H)^+$ ion concentration is *greater* than 10^{-7}, say 10^{-5}, solution is an *acid* and if *less* than 10^{-7}, say 10^{-10}, solution is an *alkali*.

The expression *hydrogen ion concentration* is shortened by the term 'pH value'.

The concentration of (H) ions can be represented in terms of a power of 10. The index alone will then be the variable, and negative, quantity.

To avoid use of cumbersome exponential functions and negative signs, the logarithm of the $(H)^+$ ion concentration, to the base 10, with sign reversed, is used for expressing acidity or alkalinity eg a $(H)^+$ ion concentration of 10^{-9} is expressed as 'pH 9'.

A 'pH value' of 7 represents a *neutral* solution.

A 'pH value' less than 7 represents an *acid* solution.

A 'pH value' greater than 7 represents an *alkaline* solution.

Whilst the necessity for avoiding low pH conditions is well understood, it is less widely realised that excessive alkalinity is also obnoxious. At the optimum pH region of 10 a hard impervious magnetite film is formed on the metal surfaces and so acts as a considerable barrier to corrosion. High pH levels above the optimum figure encourage excessive growth of the magnetite layer which break away under fluctuating thermal conditions, thus exposing new steel surfaces to corrosion attack.

Base exchange softener

These are becoming more popular of late, possibly due to the sales drive of a particular chemical company. Ion exchange is used in many kinds of industrial processes. For water treatment the base exchange process is the cheapest to buy and simplest to run. Basically the plant consists of a cylinder containing a specially prepared resin (Zeolite is one) through which water is pumped. In this vessel, calcium and magnesium ions are exchanged for sodium ions, the product being sodium carbonate which is soluble and therefore does not form scale. When the ion exchange capacity of the resin is exhausted it is regenerated with common salt, the calcium ions being flushed to drain. Such treatment will produce soft water cheaply and reliably for years. Unfortunately, the disadvantage of the base exchange process is that there is no reduction in total dissolved solids and alkalinity.

Dissolved gases in boiler water

Oxygen, nitrogen, and carbon dioxide, being components of the atmosphere, are always found in appreciable amounts in boiler and feed water, and the decomposition of chemicals commonly added to remove oxygen and adjust the pH value may in turn give rise to ammonia and sulphur dioxide. All of these gases can in certain conditions be harmful to boilers. Experience suggests that there is a tolerance level for dissolved oxygen which varies according to the operating conditions of a particular plant. This tolerance is lowered as working pressures and temperatures are raised and can vary from 0.04 ppm oxygen concentration at boiler pressures below 200 psig to less than 0.015 ppm at 500 psig.

Dissolved oxygen

Severe corrosion will occur in the boiler and feed water system if water contains dissolved oxygen in concentrations above a certain limiting value. While it may be desirable in theory to remove oxygen completely, in practice the residual limit arrived at should depend upon the working conditions. Little useful purpose will be served by reducing the dissolved oxygen content to a point at which the reaction between water and iron proceeds at a greater rate than that between the iron and the dissolved oxygen. In fact small traces of dissolved oxygen may serve a useful purpose by combining with the liberated hydrogen to form water.

Dissolved sulphur dioxide

This or sulphurous acid from decomposition of the chemical deoxidant calcium sulphite can contribute to the corrosiveness of condensate. The degree of decomposition which occurs depends upon the sulphite concentration, the pH value of the boiler water, and boiler pressure. Sulphite dosage should be limited to as low a rate as possible consistent with removal of oxygen.

There are conflicting opinions as to whether sodium sulphite is preferable to hydrazine as an oxygen scavenger. Although sodium sulphite is less expensive than hydrazine, hydrazine is often preferred since its final reaction products with oxygen are nitrogen gas and water. In addition, whereas the use of sulphite can give sulphur dioxide in the steam leading to acid conditions in the condensate, thermal breakdown of hydrazine yields ammonia. This can be desirable as it raises the pH of the condensate without any possibility of increasing the boiler water pH beyond the ideal figure.

Hydrazine serves two functions, as an oxygen scavenger and an alkaliser. It is a colourless explosive liquid, but in its diluted form it is quite safe to handle. The reaction between hydrazine and oxygen proceeds very slowly at low temperature but reacts rapidly with an increase to higher temperature — hence its use in high pressure boilers. In practice a slight excess of hydrazine is added to the feed water, as some of it is used up in reducing scale components, etc, in the boiler. It is usually added until there is a slight trace of ammonia detectable in the condensate, under which conditions it is certain that no dissolved oxygen remains. It is fair to say that substantial evidence exists to support the view that ammonia, whether derived from hydrazine or not, may accelerate corrosion in feed systems containing carbon dioxide. The use of hydrazine as an oxygen scavenger in systems free from carbon dioxide, or in systems not incorporating copper or copper alloys, may be strongly supported. Sodium sulphite may be used safely as an oxygen scavenger in systems where the use of hydrazine is contra-indicated.

Electrolytic effect of copper

There is some disagreement as to the part played by copper in accelerating or even being one of the primary causes of corrosion, but many competent authorities support the hypothesis that the presence of copper in a steel boiler accelerates corrosion. When metallic copper derived from copper alloys within feed water components comes into contact with the steel boiler tubes, a multiplicity of simple galvanic cells are established. Iron is anodic with reference to copper and so combined with an electrolyte the iron will dissolve.

Caustic embrittlement

The dangers of caustic soda have often been over-dramatised. Many of these dangers are left-overs from the days of riveted construction, when shielded cavities on the waterside could contain almost concentrated caustic soda for years on end and heavy scale deposits provided ideal concentration points.

In modern boilers, free from riveted or lap joints and highly stressed zones, the likelihood of caustic embrittlement due to concentration of caustic soda is negligibly small.

Filming amines

These are used in the protection of condensate systems. They act in two ways:

a. neutralising amines act as direct neutralisers of the carbon dioxide in the condensate;

b. filming amines form a molecular film on the internal surface of pipes, etc, to prevent oxidation.

Although filming amines have been used in the hospital service, there are restrictions on their use. No filming amines should be allowed to come into contact with cooking, food processing or sterilising processes, due to their degree of toxicity — see HTM 6.

Boiler tube failure

A common mode of boiler tube failure is by overheating of the tube wall beneath a deposit of sludge or corrosion product, having its origin at some place away from the point of failure. That tube failures can occur in this manner is well known, and it is accepted that the bulk of the deposit is the product of corrosion in the condensate/feed water system.

Hard glass-like scales form, which although thin have an extremely high thermal resistance. Analysis of such scales clearly indicates the origin of their constituents as the ferrous and non-ferrous materials in the pre-boiler systems.

Excessive feed water make-up must be avoided, as raw water introduces impurities into the system which have then to be removed or neutralised as previously described. In this area both mains water and borehole water are used, which presents different problems to different hospital engineers:

Mains water analysis

Non-carbonate hardness	43 ppm
Carbonate hardness	105 ppm
Chlorides	38 ppm
Dissolved solids as such	321 ppm

Borehole water analysis

Non-carbonate hardness	265 ppm
Carbonate hardness	260 ppm
Chlorides	400 ppm
Dissolved solids as such	1140 ppm

In a well run boiler plant the percentage make-up should not exceed 10%, although this may well be exceeded where equipment using direct steam injection such as a laundry, is in operation. Where the percentage make-up greatly exceeds this percentage, a thorough check must be made of the feed water and condensate systems. Condensate loss is also an unwanted loss of energy.

Boiler water and feed water treatment is a specialised function and advice should be sought from the experts. Any chemical company involved with water treatment will readily offer advice on what treatment is best for any particular boiler plant. Boiler and feed water is invariably treated at the following points: hotwell, feedline to the boiler, and dosage pots on the boiler. Treatment varies between manual and automatic injection of the necessary chemicals, and will depend upon the type and size of plant in use. Where possible it is advisable to install an automatic treatment system. My experience has proved to me that manual control invariably produces erratic conditions which vary widely from day to day.

Water tests should be taken regularly at the following places: boiler, hotwell, condense line or receiver, steam header.

Tests should be taken at intervals of no longer than one week, and more frequently where new plant or treatment is being introduced.

Idle boilers

This paper would not be complete without some reference to protection of idle boilers and fireside corrosion.

Where boilers are to be idle for a small period of time, say less than 72 hours, it is only necessary to increase the alkalinity within the boiler by approximately 10%.

Where periods of longer than 72 hours are envisaged, the boiler should be completed filled with correctly treated water, ensuring that an adequate oxygen scavenger is present. Regular tests should be carried out to ensure correct treatment levels are maintained.

Where the boiler will be idle for an excessively long period, several weeks or months, an alternative to completely filling the boiler is to drain the boiler completely. The boiler should then be dried out, top and bottom manholes opened, and trays of a suitable drying agent inserted. This will ensure a dry atmosphere within the boiler.

Corrosion

Fireside corrosion

The breakdown of boilerplant is always inconvenient and often very expensive. Fireside corrosion is often one of the causes of breakdown, particularly in plant which is subject to frequent start-up conditions, and which is using a fuel with a high sulphur content. Any form of corrosion of heat transfer surfaces can give rise to high maintenance costs, shortened working life and reduced boiler efficiency. Basically, there are two quite separate types of corrosion. There is high temperature corrosion which occurs above 600°C, where elements within the residual oil fuse into a slag and adhere onto metal surfaces. This type of corrosion will very seldom if ever be met within the hospital service. The other type is low temperature corrosion which occurs at temperatures below 150°C and occurs on the fireside of boiler surfaces. Low temperature corrosion occurs in two ways, namely:

Acid dewpoint corrosion

When fuel burns, any sulphur present oxidises to form sulphur dioxide. A small percentage of this in turn combines with any excess oxygen present to form sulphur trioxide. Water vapour, formed by the combustion of hydrogen present in the fuel combines with the sulphur trioxide to form sulphuric acid, which then condenses out at the acid dewpoint, reaching a maximum at 110° to 130°C, with the subsequent corrosion of any metal with which it comes into contact.

Boilers using either town or natural gas are not subject to acid corrosion attack, as the sulphur content within the gas is minimal. However, liquid condensation can occur below the dewpoint temperature, which will encourage corrosion of any metal surfaces.

Boilers using fuel oil containing a relatively high sulphur content are prone to acid corrosion if the flue gas exit temperatures are not maintained above the acid dewpoint temperature. Fireside tube cleaning is essential. Any acid formed soaks into deposited dirt scale, etc, and forms a highly corrosive mixture.

Water dewpoint corrosion

This form of corrosion is mainly associated with LTHW boilers, and is unlikely to occur in HTHW or steam boilers. It is caused, except when starting up from cold, by the remainder of the sulphur dioxide present in the gases combining with water vapour formed at water dewpoint temperature (48°C) to form dilute sulphorous acid.

The greatest corrosion rate occurs during cold start-up, when the boiler contents and surfaces are cold. As metal surfaces do not greatly exceed the temperature of the boiler water, it is the temperature of the water rather than the temperature of the gases which has the greater effect on the heated surface temperature.

It is, therefore, advisable to raise the temperature of the boiler water above 48°C, where possible, before flashing-up the boiler. Most modern boilers cater for this by having steam injectors or recirculation connections fitted.

Conclusion

I hope that this paper will help new entrants to the service to appreciate and understand the importance of good boiler water treatment. Water treatment is constantly improving. Enormous steps have been made since the days of zinc plates and a bucket of lime being added to a boiler after each internal cleaning.

No matter what type of boiler you are responsible for, it has to last for a long time, usually several decades. Therefore, proper care and attention is required from hospital engineers. Every new entrant is advised to make himself familiar with the type of boiler and treatment being used in his hospital, and to study any literature provided by the boiler manufacturer and chemical suppliers. Above all, do not hesitate to ask questions and pick the brains of your colleagues.

Finally, boiler operating problems invariably fall into four categories:

1. Scale formation;
2. Corrosion;
3. Foaming and carry-over;
4. Caustic embrittlement;

so make yourself fully aware of their implications and effect on the plant for which you are responsible.

Classified Advertisements

APPOINTMENTS AND SITUATIONS VACANT

South West Thames Regional Health Authority

Principal Assistant Engineer (Mechanical)

We are looking for an engineer experienced in the design of mechanical building engineering services, as related to hospitals and other Health Service buildings. It is desirable, but not essential, that the applicant has experience in the actual design of hospitals. But more important is that he/she should be a well experienced engineer, capable of directing a team on the design and contract management of schemes ranging from medium to very large size.
Applicants must be Corporate Members of the Institute of Mechanical Engineers. Corporate Membership of the Chartered Institute of Building Services would be an added advantage.
Location of post: Paddington.
Salary scale: £5,676-£6,858 per annum plus £354 per annum London Weighting.
Application forms from: Personnel Officer (S2), 40 Eastbourne Terrace, London W2 3QR.
Completed forms to be returned by April 15 1977.

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Contact: Robin S. Stevens, Personnel Dept. Ext. 2001.

CLASSIFIED ADVERTISEMENTS — *continued from previous page*

APPOINTMENTS AND SITUATIONS VACANT

SOUTH HAMMERSMITH HEALTH DISTRICT (T)

ASSISTANT BUILDING SUPERVISOR

(two Posts)

Salary Scale: £3,342-£3,747

Applicants must have relevant experience in the building industry, the supervision of staff, and should hold an Ordinary National Certificate in Building or equivalent qualifications.

The persons appointed will assist in the supervision of a wide range of maintenance tasks in the District. The duties will include general maintenance responsibilities and preparation of drawings and specifications.

Informal visits to the Department for the posts may be arranged through the District Building Officer, Mr. John Bullen (Tel. 01-741 0517), and the closing date for the return of application forms is April 19 1977.

Job descriptions and application forms for the above posts available from Edna Francis, District Personnel Department, Charing Cross Hospital, Fulham Palace Road, London W6 8RF. Tel. 01-748 2040, ext. 2997.

Lancashire Area Health Authority — Blackburn District
Queen's Park Hospital — District Works Department

ASSISTANT DISTRICT ENGINEER

We are hoping to appoint a suitably qualified and experienced person to fill this third-in-line post to complete the District Works Management Structure. The person appointed will be given delegated responsibility for certain aspects of the Engineering Services within the District.

Salary scale: £4,371 to £5,262 plus £291 pay award.

Application forms and further details available from the District Personnel Officer, Health District Central Offices, Queen's Park Hospital, Blackburn. Tel. 661311. Closing date: April 15 1977.

North West Thames Regional Health Authority

TECHNICAL OFFICERS

required to carry out design for electrical installations in hospital works projects.

Applicants must have served four years as a Technical Assistant Grade I in the Health Service and should normally have HNC.

Salary scale: £4,962-£5,931 plus £354 per annum London Weighting. Supplement of £123 per annum payable at minimum until June 30 1977.

Application forms available from Regional Personnel Officer, North West Thames Regional Health Authority, 40 Eastbourne Terrace, London W2 3QR (Telephone: 01-262 8011 Ext. 261), quoting Ref. 143. Closing date for receipt of application forms: April 27 1977.

BRISTOL HEALTH DISTRICT (TEACHING)

HOSPITAL ENGINEER

required to be responsible to the District Engineer for the operation and maintenance of three hospitals in the City Centre Sector.

Applicants should have completed an Electrical or Mechanical apprenticeship and hold a Higher National Certificate in Mechanical or Electrical Engineering with appropriate endorsement or other approved qualifications detailed in circular P.T.B. 261.

Salary scale £3,615 to £4,140 plus £291 annual supplement, up to 15% bonus and £183 responsibility allowance.

Closing date for receipt of application forms is 14 days from the publication of this advertisement.

Job description and application forms from Miss P. Scott, Assistant Personnel Officer, District Personnel Department, 10 Marlborough Street, Bristol BS1 3NP. Tel. Bristol 290666, ext. 209.

Hertfordshire Area Health Authority North West District

Hemel Hempstead General Hospital, Hillfield Road, Hemel Hempstead, Herts.

ASSISTANT HOSPITAL ENGINEER

To assist the Hospital Engineer in the efficient operation and maintenance of all engineering plant and services including steam raising plant.

Candidates should have completed an apprenticeship in mechanical or electrical engineering and possess an ONC or equivalent qualification. The successful applicant will be expected to reside within easy reach of the hospital.

Salary scale: £3,063-£3,507 plus £141 p.a. Outer London Allowance and £291 pay supplement.

Application form and further information available from the District Works Officer, St. Alban's City Hospital. Tel. St. Alban's 52211 ext. 229.

North West Thames Regional Health Authority

PRINCIPAL ASSISTANT ENGINEER

Salary scale: £5,571-£6,831 plus £312 per annum London Weighting (plus Supplement £105 per annum at minimum payable until June 30 1977.

The successful candidate will be responsible for the management of a team of mechanical or electrical engineers engaged on the planning and development of new hospital projects in all stages from design to commissioning.

A broad appreciation of mechanical or electrical engineering services is required, and knowledge of developments in hospital engineering services and design is desirable.

Applicants must be corporate members of the Institution of Mechanical and/or Institution of Electrical Engineers.

For an application form please telephone 01-262 8011 Ext. 261, or write to the Regional Personnel Officer, North West Thames Regional Health Authority, 40 Eastbourne Terrace, London W2 3QR, quoting Ref. 142. Closing date: May 11 1977.

CLASSIFIED ADVERTISEMENTS
— *continued from previous page*

APPOINTMENTS AND SITUATIONS VACANT

HOSPITAL ENGINEER

Accountable to District Engineer and based at North Wales Hospital, Denby. Sub-group consists of three other hospitals in area. Salary scale: £3,351 to £3,942 plus £50 responsibility allowance and £291 supplement.

Applicants must possess HNC or HND in Mechanical or Electrical Engineering, with endorsements in Industrial organisation and management or equivalent qualification. A knowledge of efficient operation or mechanical fired steam boiler plants and preferably with a wide experience of mechanical and electrical services in hospitals.

Application form and job description from District Administrator, Phianfa, 83 Russell Road, Rhyl. Further information may be obtained from District Engineer, North Wales Hospital, Denby. Telephone Denby 2871 Ext. 70. Closing date for applications: May 1 1977.

Area Works Department, Altrincham

Two Assistant Engineers

who have served an apprenticeship in Mechanical or Electrical Engineering and must hold an ONC in Engineering or approved equivalent qualifications.

Salary scale: £3,063-£3,507 plus supplement of £291 per annum.

Post I — to assist in the supervision, operation and maintenance of the engineering services in the Southern Sector of the Authority. The successful applicant will be responsible to the Hospital Engineer and be based at Altrincham General Hospital.

Post 2 — to join the design team based at Altrincham Maternity Hospital. The successful applicant will be responsible to the Area Engineer and shall prepare drawings and specifications for services as provided in hospitals.

For application forms and job descriptions, men or women should apply to the Area Personnel Officer, Trafford Area Health Authority, Oakland House, Talbot Road, Old Trafford, Manchester M16 0PQ. Closing date: April 25. Ref. D/5/77.

trafford area health authority

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