HOSPITAL ENGINEERING

October 1977

The Journal of the Institute of Hospital Engineering

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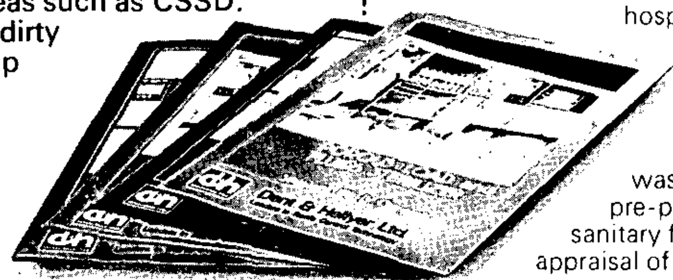

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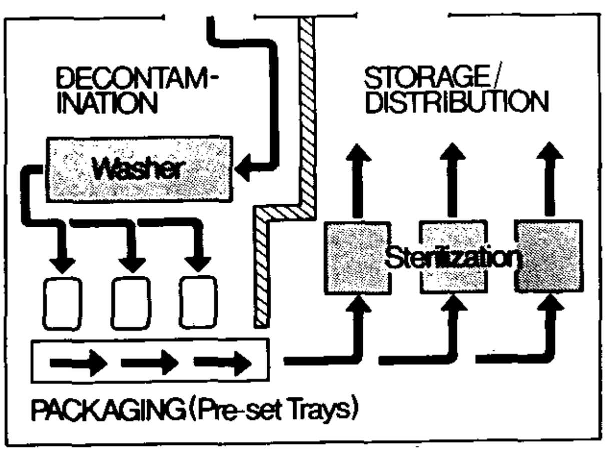

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Dent & Hellyer Limited, Walworth Road, Andover, Hampshire, SP10 5AA
Telephone: Andover (0264) 62111

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

Printed by JB Offset Printers (Marks Tey) Ltd.
Station Approach, North Lane,
Marks Tey, Colchester, Essex

Individual copies cost
£1.70 UK postage paid

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

Average circulation per issue
(January-December 1976): 2,228

ABC

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UK ISSN 0309-7498

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HOSPITAL ENGINEERING

October 1977 **Vol. 31 No. 8**

The Journal of the Institute of Hospital Engineering

Contents

Institute News

Council News

1978 Annual Conference

Next year's Annual Conference will be held in the Royal Hotel, Cardiff on April 26, 27 and 28.

The Conference Dinner Dance will be held on the evening of Thursday, April 27, when there will be a number of distinguished guests.

On the first evening delegates, and their ladies, will be guests at a Civic Reception to be given by the Lord Mayor of Cardiff.

Once again, there will be a special Ladies' Programme, as this is becoming a most popular feature of the Annual Conferences. The Conferences, although they attract increasing attendances each year, culminating in the 'best ever' at Pitlochry this year, still very much retain that welcome 'family air'. Let us hope that the trend is continued in Cardiff.

Full details, including the technical programme, will be distributed at the turn of the year.

Incidentally, it is interesting to note that Council is already giving consideration to the location for the 1979 Annual Conference.

One-day Symposiums

The support for these speaks for their popularity (150, 200 and 250 respectively this year) and so three further one-day Symposiums are planned for 1978. The question of the venues is reviewed regularly but the general ease of travel to London is a forceful factor.

Bursary, or scholarship

Council hopes to finalise within the next few weeks all the details relating to a Bursary, and the attendant competition, which is being established, and which, it is hoped, will commence on January 1 next.

Committee of Inquiry into the engineering profession

The Institute has been invited to offer written evidence to the Committee of Inquiry. A Council Working Party, headed by the President, has been established to prepare the necessary draft.

As was the case with the Institute's submission to the Royal Commission on the National Health Service, Council will welcome the comments of Branches, or of individual members, when drawing up the Institute's evidence.

'Keele' Management Courses, H E C Falfield

The Institute has continued to be involved in certain aspects of these courses, following their transfer from the University of Keele to Falfield.

Incidentally, Council and Council Committees held routine meetings at the Centre in June and are grateful for being accommodated in this way.

Supply Board

The DHSS has invited the Institute to offer its views on the possible establishment of a Supply Board, its constitution and its operation.

Watt Committee on Energy

The Institute continues to be represented on the Watt Committee on Energy. In fact, by the time this issue of *Hospital Engineering* appears, that Committee should have published its second Report.

International affairs

As members already know, the Fifth Congress of the International Federation of Hospital Engineering will be held in Lisbon from May 26 to 31, 1978. The actual location is the Gulbenkian Foundation Building which, from all reports, is a quite magnificent venue. There will be a limited form of an exhibition with the Congress, allowing the display of official and professional 'project designs' and models.

Council of IFHE has now determined to stage courses for 'senior-echelon management' during the 'non-Congress' years and the Institute has been asked to look into the question of its staging the first of such courses, possibly of three weeks' duration, in the United Kingdom during 1979.

The Institute Library

R. G. Smith, the Honorary Librarian, reports increasing calls upon his services. Apart from the lending of rather more books following the publication in the Journal of the list of books held, Mr Smith receives, and is engaged in, correspondence 'with the four corners of the earth'. There is no doubt that this is a most useful service that the Institute provides.

Branch Chairmen's Jewels

All Branches now possess a most handsome Chairman's Jewel. The Jewels were supplied centrally but most Branches have already covered the cost of an individual Jewel by an appeal within the Branch membership.

The Institute Journal

Council's Publications Committee would wish the opportunity taken to appeal to readers to offer contributions for consideration for publication in the Journal. Technical papers, articles, letters to the Editor and, indeed, items of Branch news (not *all* Branches submit reports for inclusion) — ALL are welcome and don't forget that so far as technical papers are concerned there is always the Northcroft Silver Medal to be won each year.

The Institute's Articles of Association

Council is considering the position relevant to those Clauses of the Articles of Association which govern the categories of membership, in light of changed circumstances in recent years. In any event, certain changed wording will become necessary and the Institute is in contact with the Council of Engineering Institutions and the Engineers' Registration Board.

Any proposed changes, of course, would be communicated to the entire membership, as is would be necessary for these to be approved at a general meeting of the Institute.

Finance

Council's Finance and General Purposes Committee continually reviews the Institute's finances.

Having held subscription rates firm for the last two years despite the continuing heavy rate of inflation, Committee feels it prudent that an increase should be made to rates for 1978 and have made such recommendations to Council.

The new rates will be advised to members in due course, in the usual way and a fresh standing order form will be sent to those members who pay their subscription by banker's order and they are URGED to send the new forms on to their banks, as failure to do so only gives rise to extra work and correspondence which is in itself costly and, therefore, self-defeating to a degree.

Provided that costs do not take a startling upward turn, Council will hope to be able to hold the new rates for at least two, and probably, three years.

Bernard Lucas

The recent investiture of Dr Bernard Lucas as an Officer Brother in the Order of St. John gives an excuse — if one were needed — for us to remind members of the outstanding contribution Dr Lucas has made to medical engineering.

As our front cover shows, Dr Lucas was invested by Lord Caccia. The investiture is by consent of the Queen, Sovereign Head of the Order, and is in recognition of service to mankind.

Dr Lucas JP FFARCS CIMechE PPI HospE was the President of the Institute for the two years from April 1973. Born in Dorset, he began his career with Supermarine, where he worked on the S6B Seaplane for the Schneider Trophy, which was the forerunner of the world-famous Spitfire. Due to the world depression the 1930s he was forced to change to medicine, and qualified as a doctor shortly before the war. At that time he joined the RAF volunteer reserve, and throughout the war served with the RAF medical service. He spent some of his time in hospitals, and the other on research into effects of altitude on the human body.

After demobilisation he joined University College Hospital as a consultant anæsthetist, and subsequently joined the staff of the Hospital for Sick Children, the Brompton Hospital and the National Heart Hospital. He is now senior Consultant at all of these.

Dr Lucas has always been particularly interested in collaboration between medicine and engineering. His medical work has always been concerned with chest and heart surgery, themselves having a mechanical bias. In the early 1960s he set up a department of medical engineering in the mechanical engineering department of University College and the Hospital. Subsequently he also set up a new department at Brompton Hospital. Since then he has been actively engaged in setting up and running two

The Institute of Hospital Engineering One-Day Symposium

Major Hospital Building – Project Management

to be held at
The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London
on Wednesday, October 19, 1977

Large building projects often go wrong; in particular they are not completed on time or within budget. This is a world-wide experience and its cause requires further research. Meanwhile, pragmatic solutions have to be found and, no doubt, this accounts for the widespread interest, at home and overseas, in the use of project managers.

The Symposium will examine the way in which projects are managed from inception, through construction to handover; it will explore, also, the possible advantages of employing a project manager and his role, relationships and training will be examined.

PROGRAMME

CHAIRMAN for the day:
HERBERT J. CRUICKSHANK Esq CBE CEng FIMechE FIOB FBIM, Member, South East Thames Regional Health Authority; Director, Property Service Agency Board of the Department of Environment; formerly Deputy Chairman, Bovis Holdings Limited

10.00 Assembly and Coffee

10.30 OFFICIAL OPENING by
J. R. HARRISON Esq CBE CEng (Fellow), President, The Institute of Hospital Engineering

10.45 'WHY CONSIDER THE NEED FOR BETTER MANAGEMENT OF HEALTH BUILDING PROJECTS?'
Speaker: W. D. PAGET Esq, Assistant Secretary, Department of Health and Social Security

11.30 'RELATING EXPERIENCE OF MANAGING THE NATIONAL EXHIBITION CENTRE AND OTHER PROJECTS WITH HEALTH BUILDING PROJECTS'
Speaker: FRANCIS C. GRAVES Esq FRICS FIQS FRSH, Francis C. Graves & Partners, Chartered Quantity Surveyors and Project Controllers; Project Controller for the National Exhibition Centre, Birmingham

12.15 'PROJECT MANAGEMENT IN THE HEALTH SERVICE — THE PROBLEMS AND POSSIBLE SOLUTIONS'
Speaker: G. BROOKE Esq MSc(Eng) CEng MICE, Regional Works Officer, Mersey Regional Health Authority

13.00 LUNCH

14.00 INVITED CONTRIBUTIONS AND OPEN FORUM

16.00 CLOSURE

Tickets available £9 each (including Coffee and Lunch) from the Secretary, The Institute of Hospital Engineering, 20 Landport Terrace, Southsea PO1 2RG.

large intensive care units — again an area of medicine where the patients are cared for at least partly by mechanical means. His philosophy is the introduction of engineering expertise into medicine, and not of medical 'gadgeteering'. He was one of the founder members of the Biological Engineering Society and of the medical engineering working party of the Institution of Mechanical Engineers, of which he is still Chairman.

The list of committees and other bodies on which Dr Lucas has served is almost endless. Most recently he was appointed Chairman on the Personal Safety Panel of the British Standards Institution. Apart from those BSI committees of which he has served — chiefly those concerned with life-saving equipment — he is also Chairman of the rescue and resuscitation committee of the Medical Commission on Accident Prevention and a member of the research committee of the National Fund for Research into Crippling Disease. He is also assistant chief medical officer to St John Ambulance Association and medical advisor to Royal Humane Society. Dr Lucas has also long been connected with publishing, acts as an advisor to two publishing companies, and is Editor of the publications Community Health and Engineering in Medicine.

Almost unbelievably, Dr Lucas finds time to sit as a Magistrate in Inner London, and to divide his spare time between London and Dorset. He is married, with a grown-up family. As a relaxation he enjoys sea fishing, and claims he would gladly give all his official appointments up in order to concentrate on it.

Letter to the Editor

Dear Sir,

The long road to Riyadh

I will shortly be taking up a post of Hospital Engineer at the Central Hospital, Riyadh, Saudi Arabia, and feel that my experiences of recent weeks would be well related to any other member about to undertake a similar venture.

The employing authority in Saudi Arabia *require the production of* attested and authenticated records of qualifications held, and of experience since gaining the highest qualification. An easy matter you may think — well, judge for yourself.

Step one: Photo-copy both sides of the relevant qualifications, and present these to the Department of Education and Science, Elizabeth House, York Road, London (by Waterloo Station). No fee is charged for authentication, but the originals will need to be seen. The copies only are authenticated.

Step two: Obtain from all previous employers (within the relevant period) a letter giving a simple statement of fact such as "We certify that Mr. J. O. E. Bloggs was employed by us in the capacity of ————, from ———— to ————". This should always be on letter-headed paper.

Step three: Take all the letters and qualifications copies to a solicitor and and make a statutory declaration that they are true and factual. A fee will *be charged (approximately £10).*

Step four: Take all documents to the legislation section of the Foreign and Commonwealth office, Clive House, Petty France, London, for legalisation (Room 530). A fee of £3 per document will be charged.

Step five: Take all the legalised documents to the Visa section of the appropriate Embassy to be attested, where a fee of approximately 90p per document will be charged.

You should now be ready to produce the documents as required.

Yours faithfully,

E. N. OPENSHAW

Eastmoor, Wakefield,

West Yorkshire WF1 4NN

This paper is an interim report to the Watt Committee on Energy by the two man team on Energy Conservation Experience in the Health Service. It is part of a series being published by the Committee this autumn.

Mr. Manser (the Chairman) represented the Institute of Hospital Engineering, while Mr. Sinclair represented the Institution of Mechanical Engineers.

The Rational Use of Energy

Energy conservation experience in the Health Service

Mr R MANSER BSc(Eng) (Hons) CEng MIMechE FIEE PPIHospE (Chairman), Assistant Chief Engineer DHSS

Mr D I SINCLAIR BA(Cambs) CEng MIMechE Superintending Engineer DHSS

Terms of reference

To report on the management and other measures taken in respect of energy economy in the NHS and the effectiveness of the same.

Introduction

The health service experience is noteworthy because the energy consumption figures are substantial yet this consumption is incurred by many individual mainly autonomous groups. Whilst these groups receive guidance and funding from the centre they are autonomous within the limits of good stewardship, subject to final accountability to Parliament.

Thus to some extent the conservation results may be considered akin to those of a free society subject to the instructions and pressures described herein.

Although the energy costs of the NHS are considerable in the estimated sum of £130 million for 1976/77, they are a relatively small proportion of the total annual cost of the NHS which was £3,700 million in that year. Additionally, it must be appreciated that the period since the oil crisis has coincided with the large scale reorganisation of the NHS during which management attention has inevitably been largely preoccupied with the problems arising.

The total effect of all factors indicates a progressive saving of five per cent per annum for four years in primary fuel consumption, ie just over twenty per cent, and a very small saving in electricity consumption.

The trend is still downwards and it is hoped to achieve a further ten per cent in the next two years when it is believed the economic curve will begin to bottom out.

Contents

This paper deals with the following:
1. The management and organisational steps taken to deal with the problem.
2. The tabulated changes in consumption over the years in question.
3. Primary deductions from the tabulated information.
4. The research work which has been put in hand.
5. The long-term aims.

Management and organisational policy

At the onset of the original fuel crisis the DHSS sections concerned put greatly increased effort into all aspects of energy usage and economy. This interest spans across the statutory field, the technological field, and the psychological or motivation field. In parallel with this a joint committee was set up with NHS representatives to examine the same problem, but seen through NHS eyes and with NHS input of experience and opinion. From past experience it was known that not only was the field input valuable but the final guidance resulting was normally much more acceptable than the central distribution of undiscussed documentation with implications of dictation.

Liaison links were established with DOE/PSA with their responsibilities both in respect of building policy and regulations and also in their estate management role. In this connection it is interesting to note that PSA have a line management relationship unlike the NHS/DHSS relationship.

Thirdly, it was decided that particularly in matters of energy economy motivation and inducements, full use would be made of the Department of Energy schemes and propaganda material.

The problem divides naturally several ways. First, new construction and existing estate with the latter being of predominant national importance. Secondly, the segregation into short, medium and long-term problems and measures. Thirdly, the segregation into technical and motivational aspects.

The immediate aspects of new building design were perhaps the easiest for quick policy decision. A policy instruction was issued that although the then proposed building dwelling regulation insulation levels were not statutorily applicable to health service buildings the insulation levels detailed should be regarded as minima for all new designs. This has been supplemented by the policy decision that whole life costing should be used in the design of new NHS buildings.

In dealing with the existing estate the purely technical guidance has probably been similar to that of most large organisations, insulation levels, draught proofing, boilerhouse efficiency, controls, etc. A problem perhaps more marked in the NHS is the amount of seven-day per week, 24-hour per day heated accommodation often allied to accommodation used during normal working hours. The matter of capital investment to achieve energy, and therefore economic, economy raised much more difficult problems. Just as the industrialist prefers to place available capital into production facilities or production there is always the tendency for available monies to be spent in the NHS directly on patient care. As an earnest of the DHSS intention and also for pump priming of energy economy schemes, suggesting that subsequent economies requiring capital could be funded from initial savings, the Department made a number of special financial allocations. In January 1975 £1.5 million was allocated specifically for energy conservation measures. In April 1975 £10 million was allocated for revenue savings including energy saving and a subsequent accountancy exercise revealed that approximately £4.5 million had been spent on energy conservation measures. Finally, in April 1976, £9 million was allocated for energy and revenue saving schemes.

It is believed that there is now an adequate amount of single and multi-disciplinary guidance issued to the NHS to enable good and effective energy conservation to be achieved. The one shortfall has been in the failure to evolve a satisfactory management energy economy evaluation technique suitable for national use with the minimum requirement for extra management manpower and finance. This is the problem often referred to as 'targetting'. The problem is largely bound up in the extreme diversity and age of the buildings concerned and the wide range of usage from department to department. All the schemes currently evaluated appear to require an undue management input which is not acceptable in today's austerity. Work is now proceeding on a computer programme to compare the accountancy returns for energy with some simplified building dimensions in order that 'bad' areas or departments can be thrown up for subsequent detailed management investigation.

Energy consumption figures and deductions therefrom

Table 1 presents data on hospital fuel consumption for the six years before the 'fuel crisis', 1972/3 being the last 'normal year' and for the four years since that event, the figures for 1976/7 being estimated because the annual returns from which these data are extracted are not due in until the autumn.

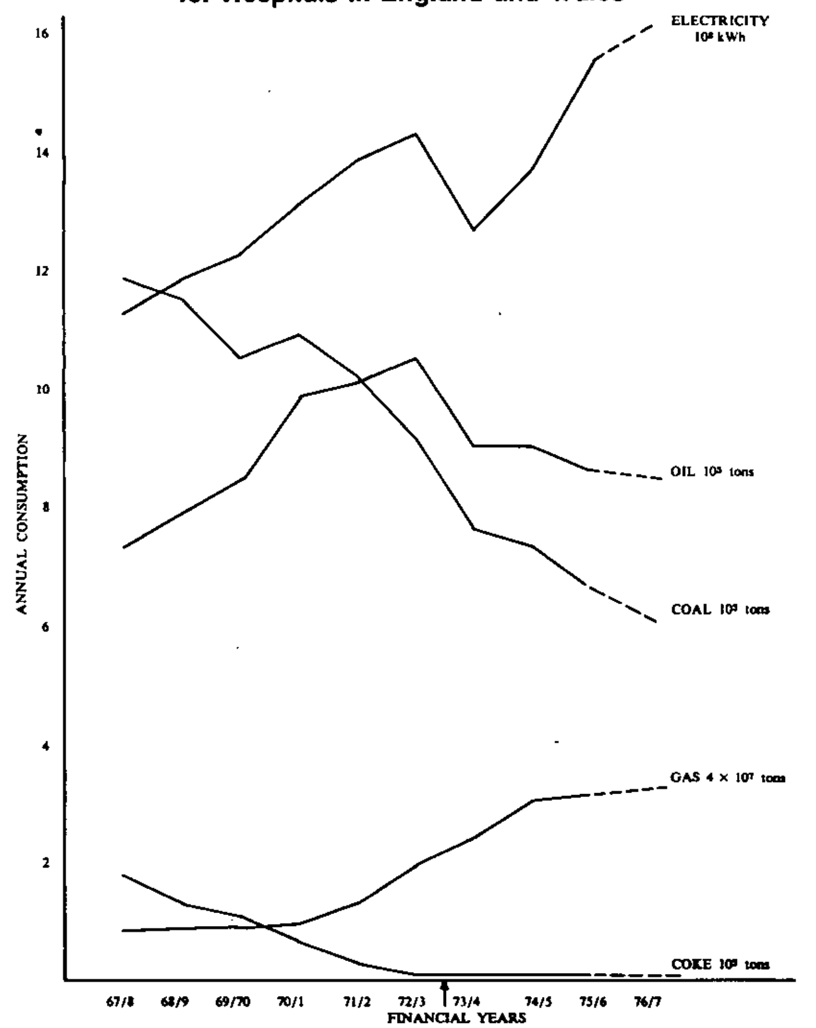
This information is presented graphically in *Figures 1* and *2*. On *Figure 1*, the trends call for some explanation. The decline in the use of coke resulted from the conversion programme away from this fuel due to greatly reduced availability following the arrival of Natural Gas — conversion was to natural gas or to oil. Until 1969/70, gas consumption was generally limited to catering and laboratory use, but thereafter the availability of natural gas on favourable interruptable tariffs resulted in conversion of hospital boilerhouses, generally at the expense of coal. Coal consumption has shown a fairly con-

Table 1. **Summary of Overall Hospital Fuel Consumption — England and Wales**
(including 4% Allowance for Cost Statements not received)

	1967/8	1968/9	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77 (Estimated)
ELECTRICITY kWh x 10^6	1,125	1,191	1,228	1,310	1,384	1,433	1,270	1,370	1,550	1,610
BTU x 10^{12}	3.84	4.06	4.19	4.47	4.72	4.89	4.34	4.68	5.30	5.50
COKE Tons x 10^3	179	131	109	65	27	8.6	8.5	8.3	8.1	8
BTU x 10^{12}	5.00	3.66	3.05	1.82	0.76	0.24	0.24	0.24	0.23	0.22
COAL Tons x 10^3	1,184	1,151	1,049	1,019	1,019	917	760	730	660	610
BTU x 10^{12}	32.08	31.19	28.44	29.57	27.63	24.84	20.71	20.02	18.09	17.00
OIL Tons x 10^3	732	794	840	987	1,014	1,056	900	900	880	850
BTU x 10^{12}	30.58	33.15	35.11	41.23	42.35	44.14	37.79	37.74	36.20	36.00
GAS Therms x 10^6	33.3	34.1	34.7	39.4	51.3	77.7	96.8	122.9	125.7	130
BTU x 10^{12}	3.33	3.41	3.47	3.94	5.13	7.77	9.68	12.29	12.57	13.00
TOTALS BTU x 10^{12}	74.83	75.47	74.26	81.03	80.59	81.88	72.76	74.97	72.39	71.72
COST £ x 10^6	27.2	27.9	28.0	31.0	37.5	38.4	45.1*	77.8*	94.9*	130.00*

* estimated values

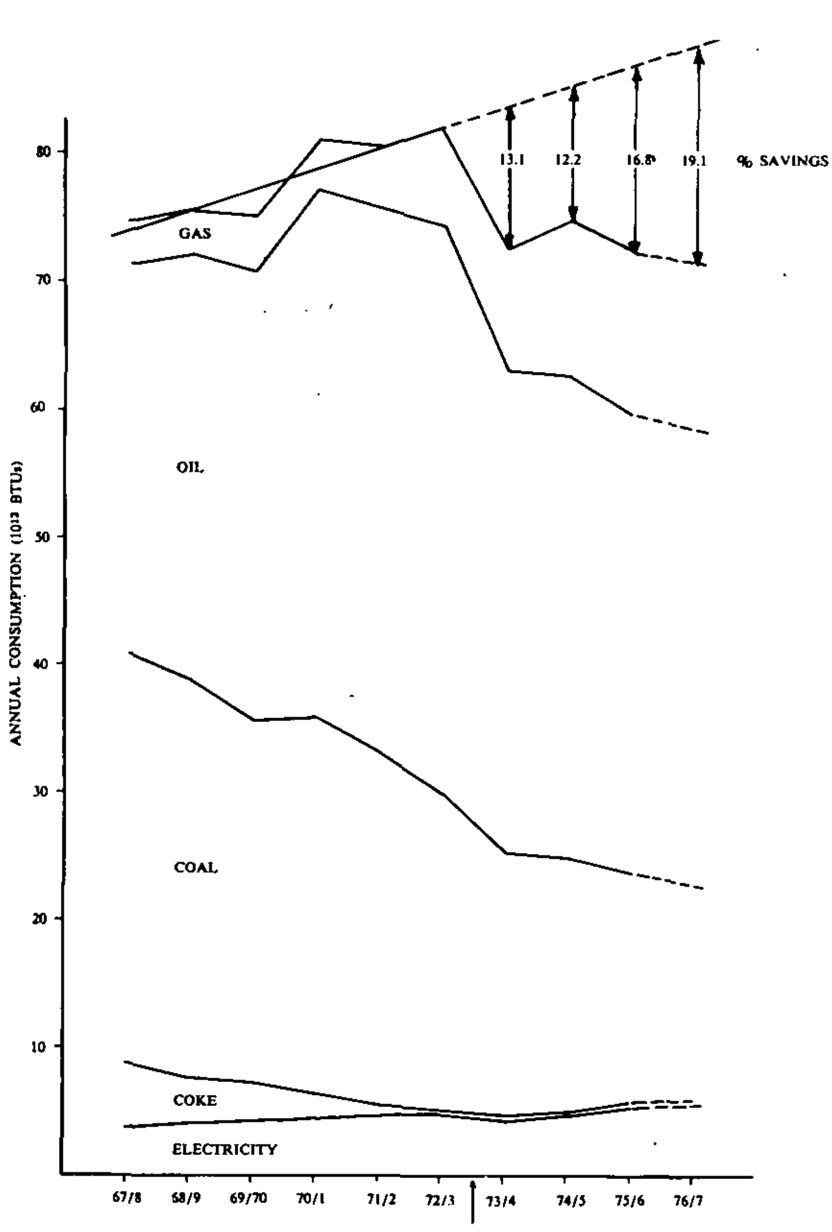
Figure 1. **Fuels and Electricity Consumption for Hospitals in England and Wales**



sistent decline, with gas and oil taking up the load with corresponding gains in boilerhouse efficiency, reduced labour and maintenance changes and the use of automatic controls for minimum attendance. It is interesting to note that the trend to oil which was levelling out by 1972/3 showed a sharp drop due to the 'fuel crisis' and since then further small reductions have been made, and that gas consumption is also apparently levelling off.

Figure 2 presents the overall fuel and electricity consumption in terms of BTU × 10^{12}. The best fit regression line for the years 1967/8 to 1972/3 for the total energy consumption has been extended as a 'trend line' to indicate what the consumption would probably have been if the energy crisis had not occurred. The annual increase of about two per cent is attributable in part to increases in the hospital estate due to new building (less closures), in part to increased use of equipment (for improved patient care, for labour saving, etc) and in part to upgrading of existing older hospital property. The percentage savings are not quite as good as had been hoped; some of these savings arise from improved boilerhouse efficiency as mentioned above but the majority of the values are indeed attributable to energy conservation measures. *Figure 3* shows the primary fuels on the one hand, and, to a different scale, the electricity consumption. The latter shows clearly that despite a 15.1 per cent drop in 1973/4, consumption is now only 4.5

Figure 2. **Energy Consumption in Hospitals in England and Wales**



per cent below its trend line, suggesting that most of the electrical 'good housekeeping' measures adopted in 1973/4 have now been abandoned. Perhaps the most noteworthy saving is the overall value of 13.1 per cent in 1973/4; this can only have been due to extreme 'good housekeeping', when the energy crisis was in everyone's mind, reinforced by electricity cuts and the three-day week, because there was no time for other conservation measures. It should also be noted that this was achieved by economies in the last five months of the financial year and gives an indication of what can be achieved when everyone is under extreme pressure.

Table II gives values for unit consumption, allowing for a one per cent annual increase in hospital volume since 1973/4, and for fuels allowing for the variation in degree days (the degree day values for the Midlands have been used, as a reasonable average for England and Wales).

These data are presented graphically in *Figure 4*. Again, the trends shown call for some comment. The unit consumption of fuel (excluding electricity) for the first six years is, apart from an unexplained 'plus-minus feature' in the middle virtually steady, the average being 29.84 millions of BTU per 1,000 cubic feet; and the trend towards higher standards is almost balanced by improved boiler-house efficiency. However, when unit consumptions are adjusted by a degree day factor applied to the fifty per cent for heating (the other half being base load to DHW, clinical and catering use, laundries, etc and mains losses, all of which are little affected by external temperature), the resulting scatter of values suggests that external conditions have little influence on hospital heating, ie, hospitals are consistently overheated, and therefore there could be big savings to be found in this area.

The drop in 1973/4 is due to the energy crisis, and the continuing decline shows the effect of energy conservation measures such as 'good housekeeping', insulation, improved heating controls, reduction of overheating, and so on.

The unit consumption of electricity again shows that the reduction in 1973/4 has been largely lost again.

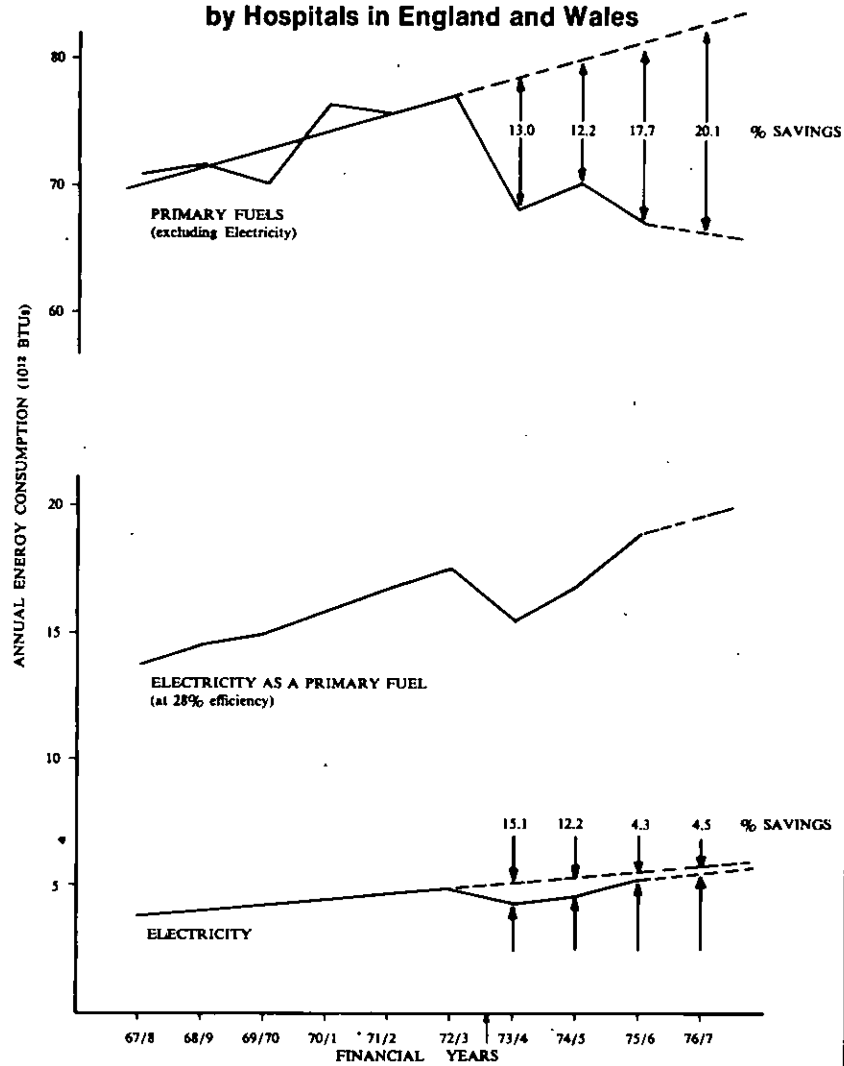
Research work

Research work currently in hand or completed is under the following main heading:

1. Analysis of services usage and draw-off. This work is required to determine new policy standards for services to provide less than 100 per cent or total service but a statistically acceptable shortfall.
2. Work on controls and control economics.
3. Evaluation work on heat reclaim devices.
4. Work on the acceptability of wider environmental swings.
5. Work on a low energy hospital. Initially this work comprises the measurement of actual energy losses over various routes for comparison with the theoretical or design figures. This work has proved unexpectedly difficult. The next stage will be the tentative design of a low energy hospital.

In the addition to the above which are funded as straightforward research and development projects the DHSS has collaborated with NHS in real life projects. That is to say, in the matter of newer technologies prospective new proposals have been examined and where the new technology is economically viable collaboration

Figure 3. **Consumption of Fuels and Electricity by Hospitals in England and Wales**



has occurred with a view to incorporation for subsequent experience and monitoring.

The first of these large scale innovatory projects has recently been commissioned being a total energy scheme for an electrical maximum demand of approximately eight megawatts. A second project shortly moving into the construction phase is an all electric mechanically ventilated block using the latest heat reclaim techniques.

The further projects in mind are firstly a building using a heat pump, probably using mechanical ventilation with the heat pump astride the inlet and extract. The second project is the low energy hospital referred to above. Consideration to date would seem to indicate a very well insulated building, with a moderate fenestration ratio, mechanically ventilated using low air velocities throughout. Heat exchange between inlet and outlet air would almost certainly be incorporated. It seems likely that foul and clean drainage would be segregated and the latter used for heat reclaim to the DHW feed.

The long-term aims

The long-term aim of the DHSS/NHS policy may be simply stated as **to reduce the total NHS expenditure on energy and energy conservation to a minimum.**

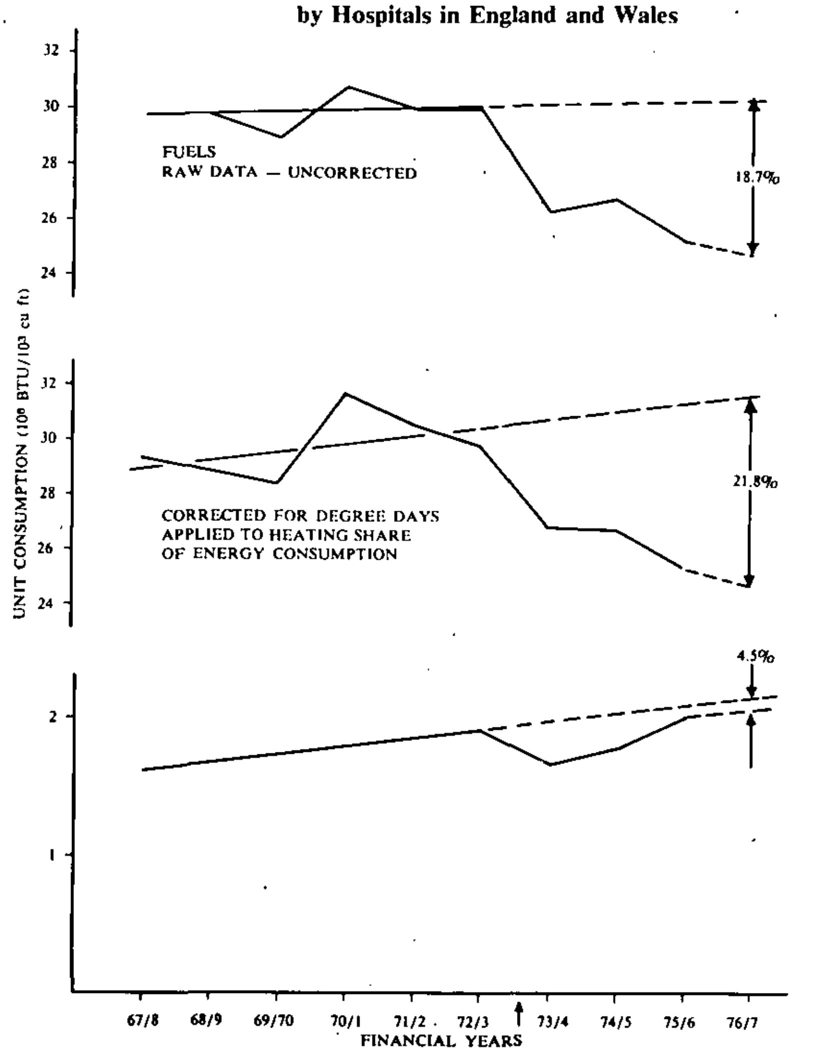
There are two strands of reasoning implicit in the above. Firstly, the balancing of energy conservation costs against the economies achieved, in

Table II. **Consumption per unit Volume of Fuels and Electricity by Hospitals in England and Wales**

Estimated

	1967/8	1968/9	1969/70	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7
FUELS CONSUMPTION (10^{12}BTUs)	70.99	71.41	70.07	76.56	75.87	76.99	68.42	70.29	67.09	66.22
HOSPITAL VOLUME (10^6 cu.ft.)	2389	2403	2421	2488	2535	2567	2600	2626	2652	2679
UNIT CONSUMPTION (10^6BTU/10^3 cu.ft.)	29.71	29.72	28.94	30.77	29.93	29.99	26.32	26.77	25.30	24.72
DEGREE DAYS (60° F base, for whole year)	4420	4550	4450	4089	4121	4343	4133	4297	4251	4395 9yr average 4295 used
CORRECTED UNIT CONS. (50% adjusted to av.)	29.30	28.88	28.44	31.55	30.56	29.83	26.83	26.76	25.43	24.72.
ELECTRICITY CONSUMPTION (10^{12}BTUs)	3.84	4.06	4.19	4.47	4.72	4.89	4.34	4.68	5.30	5.50
UNIT CONSUMPTION (10^6BTU/10^3 cu.ft.)	1.61	1.69	1.73	1.80	1.86	1.91	1.67	1.78	2.00	2.05

Figure 4. **Consumption per unit Volume of Fuels and Electricity by Hospitals in England and Wales**



short the whole-life costing which is now part of the design exercise for NHS buildings; though even this is of course vulnerable to distortion due to differential inflation rates. Secondly, there is the assumption that economic economy is the goal whereas it could be argued that the national policy should be aimed at the maximum energy economy as such.

Some work was done on the relationship between energy accounting and money accounting in the above problem. Economic or money yardsticks were clearly the only acceptable tool; firstly, because they are the universal language of administrators, accountants, engineers and all other professions concerned, secondly, because the rules of discounted cash flow and whole-life techniques are universally known and recognised, and thirdly, because in general it is recognised as the function of supporting professions in the NHS to provide an adequate, and no more than adequate, service at the minimum cost to the NHS.

Within the above basic or philosophical long-term aim it is also planned to obtain within a decade operating experience with example buildings of advanced technology.

Thus if the national circumstance requires drastic change in energy usage the then minister will have operating experience in the NHS context of the more unusual technologies such as heat reclaim and heat pumps on which to base new engineering and building policies.

Mr. Schaffel is District Engineer, Ormskirk Health District.

Flash Steam recoveries in Laundries

A W SCHAFFEL TEng(CEI) MIHospE

In the field of energy conservation it is always good policy to tackle the items that are in money terms cheap to implement, and have short cash recovery times (ie up to 12 months).

The recovery of flash steam fulfils the criteria and hospital laundries are one of the biggest sources of flash steam.

Most hospital laundries return high temperature condensate to a collecting tank or hot well where the waste heat flashes off to atmosphere. This flash is easily recoverable and the following three examples have all been tried and found to work, and to recover their cost well within 12 months.

The first thing to be aware of is exactly how much energy is being wasted by this needless discharge to the atmosphere.

If we take a laundry producing say 60,000 articles per week and using 3lb steam/lb of washing, the total steam usage would be 4500 lb/hour (assuming a forty-hour week).

If we accept that twenty per cent of this steam is for direct injection, it leaves approximately 3600 lb/hour which will return as condensate to the collecting tank or hot well.

Most laundry machines operate at between 60-100 psi. If a mean of 75 psi is accepted, we then have 3600 lb of condensate running to a collecting tank which is at atmospheric pressure. Therefore the condensate arrives with a sensible heat content of 290 Btu/lb. At 0 psi (212°) its maximum sensible heat content is 180 Btu/lb, leaving (290 − 180) = 110 Btu/lb as surplus which reverts to latent heat to re-evaporating some of the condensate.

At atmosphere pressure steam has a latent heat content of 971 Btu/lb, so with 110 Btu/lb available the amount of flash formed at atmosphere pressure $= \frac{110}{971} \times 3600 = 407$ lb/hour.

407 lb/hour every hour that the laundry operates!

If at today's fuel prices and with a medium-sized boiler plant producing steam at £2/1000 lb that is something like £2,000 thrown away every year.

How to recover it

There are a number of approaches to recovering this waste and I am going to deal with two of them.

Each approach uses redundant/scrap calorifiers/old Ogden traps. The last one described cost the most and its cost recovery time was 11 months, the others had cost recovery times measured in weeks.

Pre-heating the hospital hot water

At this particular hospital the hot water from the laundry was taken from the main hospital calorifiers and the condensate collecting tank was in a pit alongside the main calorifier house.

The vent from the tank was two inches, it gushed steam all day and every day, and the general consensus of opinion was 'you'll never stop it'.

However, a review of the calorifiers in use revealed that one was permanently out of action because the tube battery had been condemned, and as the other two calorifiers could each cope with the majority of the load it was not intended to repair it.

A word with the insurance inspector revealed that the battery was fit for steam up to 5 psi but when the pressure had been raised to mains he had asked for it to be taken out of service.

The way was then fairly clear for a solution to the problem. The condensate return from the laundry was re-routed to pass through the tubes of this calorifier and after fitting certain controls to ensure that the water could not exceed the safe limits for hot water, the calorifier was brought into service.

Results

The first result was that we could immediately isolate the back-up calorifier.

The calorifier on line was helped to the extent of reducing the opening of the steam valve from fully open to approximately half open. The vent stopped gushing steam to the atmosphere and the condensate return temperature was reduced from 217°F to 160°F.

Checking the steam meters over a period of six months showed that the steam saving had been somewhere in the region of 500 lb/hour. The total cost of the exercise was £250 (including labour).

Cost of steam at that time was approximately £1.50/1000 lb and the recovering time six to seven weeks.

Heating the soap tanks

This was in the nature of an experiment but it showed a real saving and could be well worth pursuing if other options are not open.

To keep a soap tank at 120°F usually means using a steam coil in the base of the tank, and this coil can take up to 75 lb/steam/hour depending on the temperature of the soap and the length of time it stays in the tank.

Not a great deal of steam, but if it can be saved cheaply it is worth having if as an example you allowed say 50 lb/hour, that equates to 104,000 lb/year (five-day week, forty hours) which using our current boilerhouse cost of £2/1,000 is £200.

To try out the feasibility of this an old Ogden trap was modified as a flash vessel and a by-pass was fitted into the laundry condensate main to feed a proportion of the condensate into the flash vessel.

Result

A complete elimination of steam from the mains to the soap tank.

The flash steam kept the soap tank at 120°F all day and also kept the mixing water at 100°F.

Cost

Ogden trap — £0
Modifications — £20
Time — ten hours at £2/hour = £20
Total cost — £40
Recovery time — three months.

Providing the laundry hot water from flash

This last example is the most complete scheme because it involved the removal of the laundry from the hospital hot water system. Then, by using a redundant storage calorifier, the complete hot water needs of the laundry were met.

This particular laundry used approximately 3000 lb of steam per hour of which 600 lb was used for direct injection, which left 2400 lb/hr at a mean pressure of 80 psi to produce flash. It was decided to operate the system at 3 psi and to use a remote non-storage calorifier as the heater battery (see illustration opposite).

An old 200-gallon storage calorifier was used and the heater battery withdrawn to give slightly more storage space.

A Hartley & Sugden galvanised non-storage calorifier rated at 500,000 btu/hour 3 psi was used as the remote battery.

All the condensate from the laundry passed through the area, while the kitchen condensate also passed close by on its way to the collecting tank 'B'.

This condensate was diverted into a Spirax No. 8 flash vessel pipe layout as is shown in illustration opposite.

Control system

The heart of any system using steam is the control system, and I chose a Drayton System based on their Series 70 valves and indicating dial sets. This was the most expensive part of the whole system, and on reflection it could be done cheaper by using standard control valves and reducing sets — see Appendix 1.

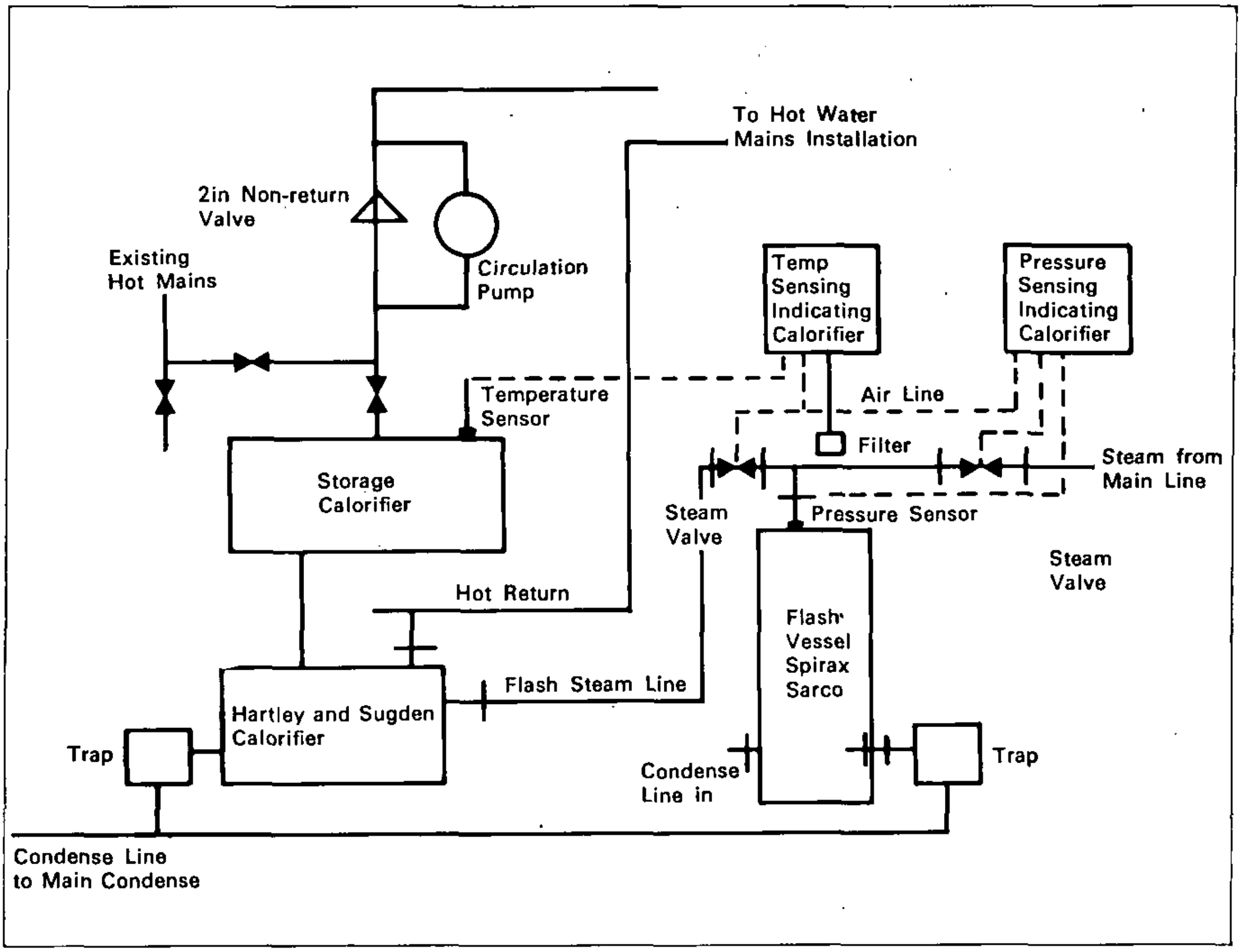
However, this system has performed faultlessly over the last 12 months and justified its relatively high initial cost.

Operation

The flash vessel is set at 3 psi, and when the flash from the condensate is insufficient a pressure sensor opens the make-up valve from the main steam line and restores the pressure.

Theory and practice

Laundry steam usage	3000 lb/hour
Steam available for condense	2400 lb/hour
Mean steam pressure	80 psi
Sensible heat content of condensate at 80 psi	= 295 Btu/lb
Sensible heat content of condensate at 3 psi	= 190 Btu/lb
Heat available for flash 295 − 190	= 105 Btu/lb



A temperature limit shuts down the whole system should the hot water go above 140°F (the hot water is only used for washing machines and not for staff washing facilities).

In practice it has been found that we can operate the flash vessel at 0-2 psi and still achieve a good steady flow of hot water.

At 3 psi steam has a latent heat of 964

$\therefore$ the amount of flash/lb = $\frac{105}{964}$ = 0.1816/lb.

If the laundry returns 2400 lb of condensate/hour.

Amount of flash available = 2400 × .108 = 259.2 lb/hour.

Heat available at 3 psi = 964 × 259.2 = 249,868.8 Btu/hour.

Heat required for laundry hot water Laundry uses 400 gallons of hot water/hour.

Heat required to raise 400 gallons from 60°F to 140°F.

= 400 × 10 × 80
= 320,000 Btu/hour.

Heat available from flash = 249,868 Btu/hour

Heat required = 320,000 Btu/hour.

Theoretical make-up required from mains supply
= 320,000 − 249,868
= 70,132 Btu/hour

with make-up steam at 3 psi amount required

= $\frac{70,132}{964}$

= 72.75 (say 73 lb/hour).

Theoretical steam required at main calorifier plant.

400 gallons of water will require 320,000 Btu/lb.

The main calorifier operates at 60 psi.

Latent heat of steam at 60 psi = 905.

Steam required = $\frac{320,000}{905}$ = 353 lb/hr.

So by using flash steam recovery we should in theory save:
353 − 73 = 280 lb/hour.

With our current boilerhouse cost of £2/1,000

The saving would be 56p/hour.

The laundry works 44 hours/week, 51 weeks/year (allowing Bank Holidays)

Total saving = 44 × 51 × .56p = £1,256/year.

Initial checks on the steam meters showed that these savings were in fact, being obtained and that the hospital calorifiers showed a steadier load pattern as a result of the removal of the heavy laundry demand.

Cost of equipment

Storage calorifier	£0
Non-storage calorifier	£140
Flash vessel	£90
Control system	£600
Pipework alterations	£100
Labour content	£200
	£1,130

Recovery time 11 months at April 1977 fuel prices.

Conclusions

These three examples show that with a little ingenuity flash steam recovery is a fairly cheap and practical way of saving fuel.

Postscript

Further checks on steam system readings show that in fact the saving was in the order of 750 lb/hour.

It is difficult to explain the extra savings except that mains losses to the laundry were reduced and the previous sudden heavy demands on the hospital calorifier were removed, thus giving a steadier load pattern and a more efficient usage.

Appendix 1

If reducing valves had been used instead of indicating controller the cost of the control system would be made up as follows:

Reducing valve set at 50 — 3 psi	£50
Spirax control valve	£150
Auxiliaries	£50
	£250
total cost would be	£880

Recovery time would be cut to nine months approximately.

However, this control system whilst perfectly adequate, does not give the flexibility of the Drayton system.

Manholes and Inspection Chambers - Use and Construction

ROLF PAYNE HN Dip FIOP MI HospE LIOB

Introduction

Traditionally, underground drainage systems for the disposal of both foul and surface water rely upon manholes and inspection chambers to act as collecting points for the network of pipes likely to be required to drain a building, or a number of associated buildings.

This method of design has been developed and perpetuated over the years by various issues of *Building Regulations* and British Standard Code of Practice 301, *Building Drainage*, and the choice of manhole covers and frames by British Standard 497, *Cast manhole covers, road gully gratings and frames for drainage purposes.*

The construction of manhole chambers is dictated by CP301 and BS 556, *Concrete cylindrical pipes and fittings including manholes, inspection chambers and street gullies.*

The Building Regulations 1976 (Part N12) give some guidance on the siting of inspection chambers and rodding eyes in relation to the drainage system; also on the selection of covers and frames. Under Part B2 — Deemed-to-satisfy provisions regarding the fitness of materials:

> The use of any material or any method of mixing or preparing materials or of applying using or fixing materials which conforms with a British Standard Code of Practice prescribing the quality of materials or standard of workmanship shall be deemed to be of sufficient compliance with the requirements of the regulations BI(1) (Fitness Materials), if the use of that material or method is appropriate to the purpose for and conditions in which it is used.

CP 301 is, therefore, an acceptable design document for 'housing, public buildings, schools, groups of industrial buildings, or similar situations that are limited to drains not generally in excess of 300mm (12in) nominal bore', but it may not be totally acceptable for hospital drainage design purposes.

Under CP 301 Section 3.12 Design of Manholes and Inspection Chambers:

> Access may be provided by inspection chambers or manholes depending upon the depth at which the drain is laid. The guiding principle in the location of manholes or inspection chambers is that they should be situated to allow every length of drain to be accessible for maintenance. The layout should be designed to satisfy the above principle, but in the interests of economy the number of access points should be kept to a minimum. The distance between access points should not exceed 90m (300 feet).

In general, and bearing in mind that the scope of CP 301 is limited to drains of the smaller sizes, manholes or inspection chambers should be provided in the following situations:

1. At all changes of direction on drains (except for drains where the change in direction is not too great for cleaning);
2. At all changes of gradient on drains (except for drains where the change in gradient is not too great for cleaning);
3. At all drain junctions where cleaning is not otherwise possible;
4. On a drain within 12m (40 feet) from a junction between that drain and another drain, unless there is an inspection chamber situated at that junction;
5. At the head of each length of drain.

A rodding eye may serve the purpose of a manhole at the head of a shallow branch drain.

It should be noted that considerable emphasis is given to accessibility in relation to cleaning. In the 19th century the only acceptable method of cleaning drains was by the manual use of cane rods. Today drain-cleaning is a semi-specialist occupation requiring a knowledge of drainage design, regulations and materials, as well as an armoury of sophisticated and expensive equipment. But, as the methods and equipment for cleaning have improved, the requirements of access have also changed, and now we do not require the proliferation of unsightly and expensive manholes and access chambers traditional to 19th-century design fashions and regulations.

There is one other source of design guidance, other than manufacturers' product information, and that is the Agrement Board Certificates. Although they are not recognised as 'deemed-to-satisfy' documents within the building regulations, they are in general accepted by authorities for planning approval.

Design objective

The objective of a designer of drainage systems is to provide a pipework network to the appliances or discharge stacks capable of removing the effluent quickly, quietly, and without disrupting the function of the building.

to take additional branches serving new appliances.

Within the health service there are a considerable number of old buildings, and with the change in use of clinical areas and the need to add to existing buildings and provide new facilities on existing sites, underground drainage systems are being subjected to alterations in design and function that are causing the works staff considerable and increasing maintenance problems. These problems do not only apply to health service buildings, but also relate to any congested building complex.

When adding to or modifying existing drainage systems, an investigation must be made to discover if the pipework will take the added flow (particularly at peak periods), if the condition of the pipework is satisfactory for the type of effluent to be discharged, and to establish how junctions between the new and old systems will be made.

In May 1954 a report based upon an extensive survey was issued by

Figure 1. Modified manhole.

The performance of a system can be judged by the number of times it ceases to function properly by becoming blocked, thereby causing disruption within the building, and a possible risk to health by the release of pathogenic bacteria.

Sanitary systems will block due to a number of inter-related factors, one of which is the design and construction of manholes and inspection chambers, and in particular their modification after initial construction

the joint committee on field research into drainage problems. It attempted to identify the reasons why blockages developed in underground drainage systems. There were 14 basic causes outlined, as well as the general one of misuse by the user of the appliances. The two reasons that are applicable to this paper states:

1. Faulty design of invert channels in manholes; branches have sometimes been brought in at too acute an angle against the flow of the main channel;

2. Defective construction of manholes, including unsuitable bricks and covers and poor rendering.

It also states that 'it is evident from the information obtained (from the survey) that the part of the drainage system at which most blockages occur is the interceptor'. Since 1954 there have been a number of changes in the Building Regulations in which attempts have ben made to eliminate the main causes of blockages. These changes include the use of flexible pipework systems, unrendered brickwork for the internal face of manholes, and the omission of interceptors, etc.

But with a changing user behaviour pattern since 1939 (for example, more women now go out to work), and the complexity of sanitary systems required for large building complexes, blockages still provide a good income for specialist cleaning companies, as well as disruption and risk to health within the buildings.

However well we design and install our drainage systems, blockages will occur due to the capricious nature of the user, and the fact that it is a gravity disposal system.

A blockage within a drainage system, particularly within a hospital clinical unit is always an emergency. Therefore, as well as attempting to eliminate blockages by good design and construction, we must provide adequate and immediate access into the system.

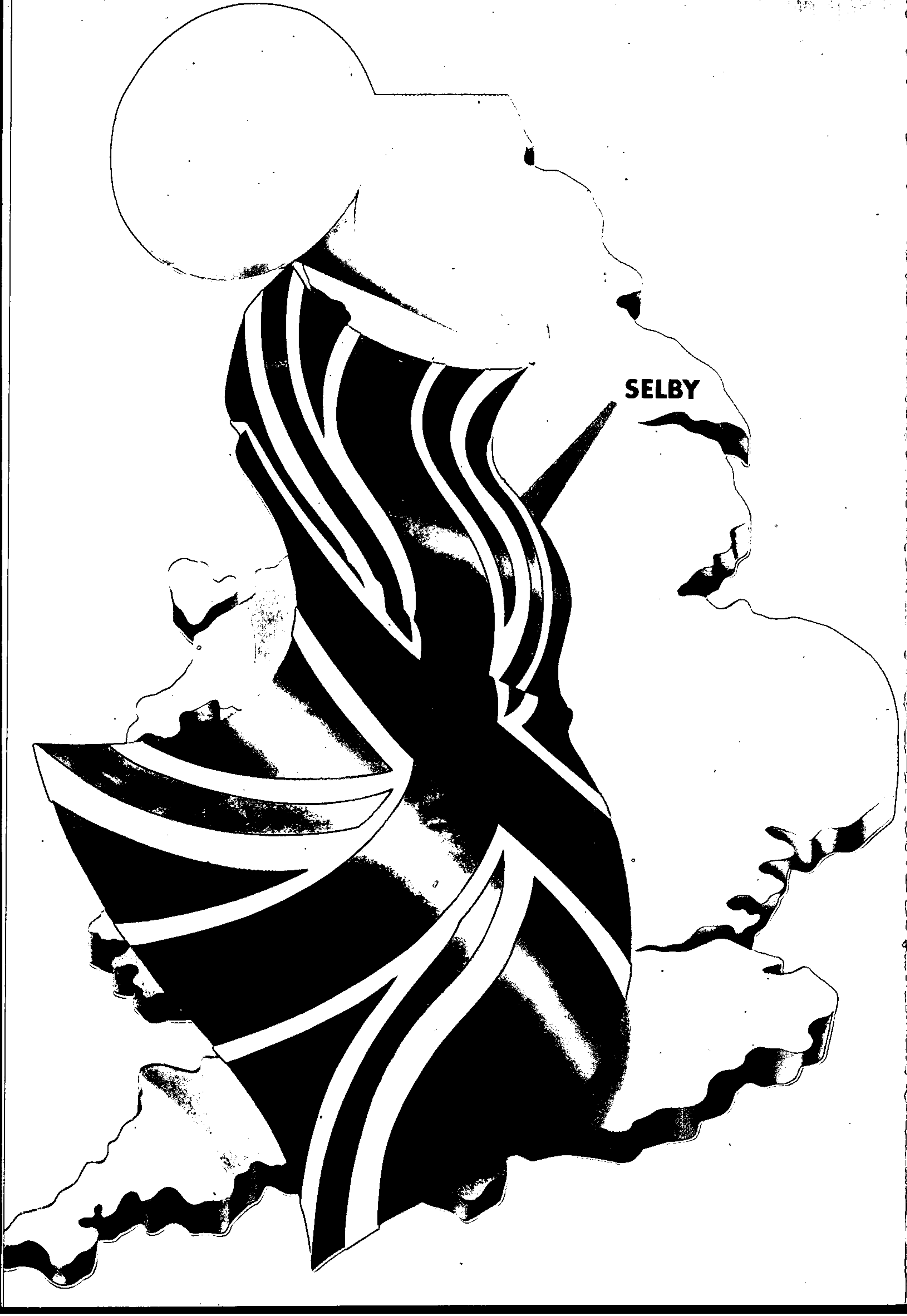
Design guidance – manhole covers

New manholes should not be positioned where access to the cover is restricted or likely to be obstructed.

Contractors working on site must not be allowed to stack building materials, rubbish skips or site temporary huts on top of manholes without providing alternative access. Not only will immediate access be denied, but the cover and drain may not be capable of taking the superimposed load. Covers should not be sited in ambulance waiting areas, or car parks.

Too often they are positioned in narrow busy roads, making any maintenance hazardous to the operators. When it is not possible to align the drain within a grass verge or pavement, rodding points must be provided to one side of the drain line in a 'safe' position.

When a cover is to be positioned in a grassed area it should be set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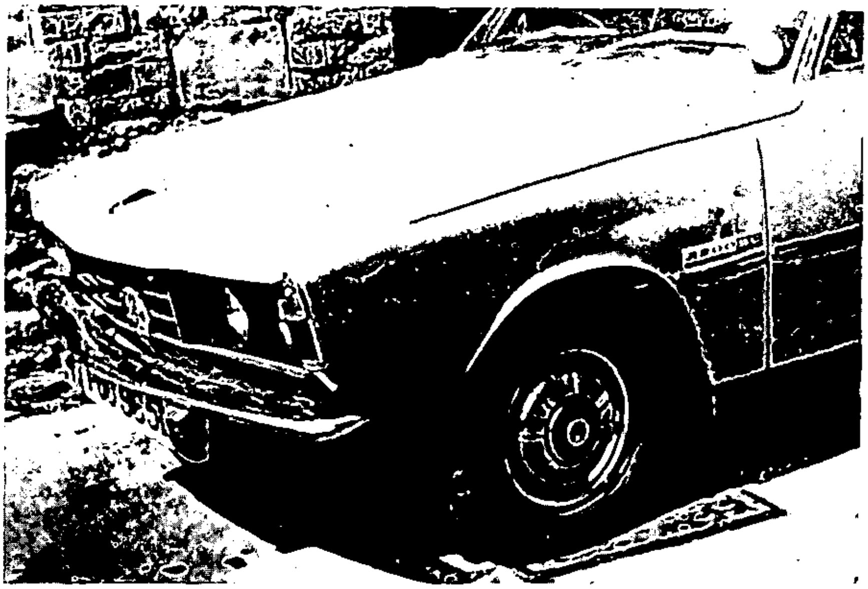
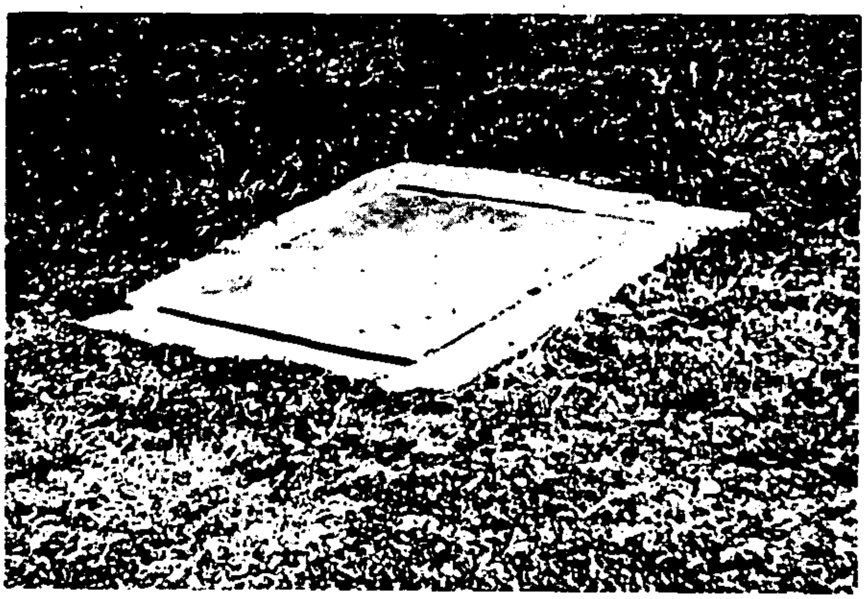


Figure 2. Car parked on top of manhole (alongside double yellow line!).

Figure 3. Manhole cover in grass.



flush with the ground and surrounded by a 200mm cutting strip.

When they are to be set in an earth border they should be about 100mm above earth level, and surrounded with a 200mm concrete strip.

Where covers are to be set in sloping surfaces, they should be protected by a retaining wall on three sides built in 225mm Class 'B' engineering bricks bedded in 1 : 3 cement mortar. The concrete base should be cast to throw water out of the recess formed by the wall thereby reducing the risk of corrosion of the cover.

If this type of protection is not employed, it is possible that after some years the cover will not be visible, making maintenance difficult. (See *Figures 4* and *5*).

Covers that are to be sited within a building corridor or internal area must be carefully positioned and installed. Where possible they should be sited away from the passage of people or trolleys. Maintenance through such covers may disrupt the flow of personnel and goods if not properly sited. There is also a risk of people catching their feet on a protruding cover, particularly elderly or infirm patients using walking aids. Such internal covers should always be recessed to accommodate the floor covering, and should be of the screw-down type.

There is an understandable temptation on architects to hide unsightly manhole covers whenever possible by devious means, but it must always be remembered that they are there to provide immediate and adequate access for emergency maintenance. They must not be tucked tightly into corners thereby making the manipulation of equipment extremely difficult, or covered by carefully planted horizontally growing shrubs in landscape schemes. The desire to place heavy, earth-filled concrete tubs on top of them must be resisted.

Loose chippings or stones are sometimes used to hide recessed covers in courtyards. Consequently the maintenance operator must first find the cover, carefully remove the surrounding stones to prevent them falling into the drain (thereby adding to the blockage) before he can obtain access; **it all takes time.**

The Health and Safety at Work, etc Act places the responsibility firmly upon the supervisory staff for 'ensuring that so far as is reasonably practicable the health, safety and welfare at work of all his employees'.

This can be interpreted that they must provide drain maintenance operators with suitable and adequate lifting equipment for freeing and moving heavy covers, as well as protective clothing. Some covers can weigh up to 250 kg and a spade, bar or even a couple of keys cannot be considered 'suitable or adequate' when there are available simple mechanical lifting devices to take all the risk and strain of this operation.

The use of these devices must be considered when positioning manhole covers and it is advisable to give a clear, firm space of at least one metre on all sides of any cover.

Covers with recessed handles, as shown in *Figure 4*, should not be used, particularly where there is a risk (such as in psychiatric and mental care units) of unauthorised people lifting them, and disposing of objects and the cover down the manhole. Not only will the hand holes become blocked with dirt, but ultimately the grip will corrode away.

When planning extensions to existing buildings, link corridors between buildings, infill units in courtyards, or especially the erection of temporary buildings, consideration must be given at the planning stage to resiting existing manholes likely to be obstructed by the proposed development, so that access is available for continued maintenance.

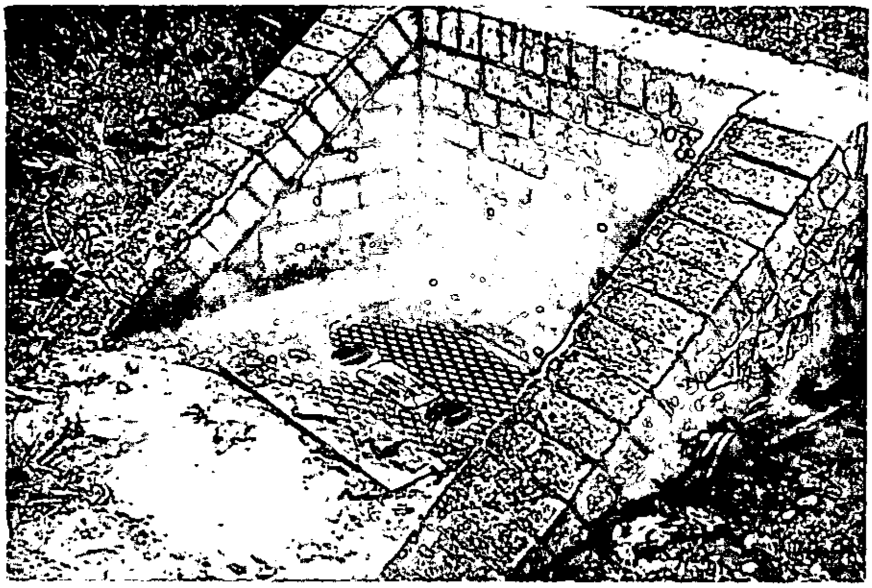


Figure 4. Cover protected by retaining walls (the type of cover shown is NOT recommended).

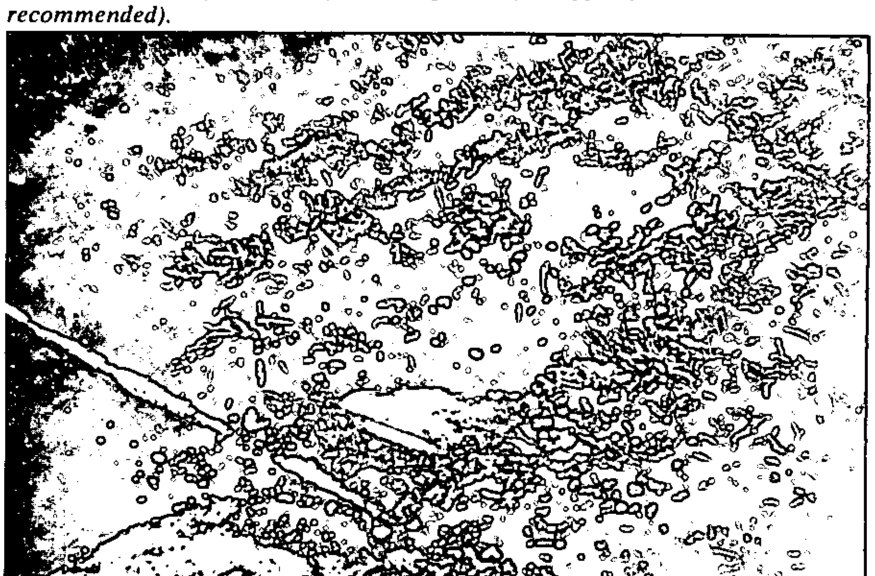


Figure 5. Cover partially obscured.

Figure 6. Stone-filled recessed covers.

Design guidance – junctions between drains

The Building Regulations and CP 301 do not insist that there is a manhole at every junction between drains, but that there is adequate access for cleaning.

To be specific, means of access must be provided on a drain within 12.5 m from a junction between drains, unless there is an inspection chamber situated at that junction. Unfortunately, designers attempt to use manholes wherever possible; particularly when funds are scarce they will attempt to save money by coupling new drains into a manhole on an existing adjacent system even if it is upstream of the new development. This is achieved by fitting acute three-quarter channel bends to bring the flow back into line. This practice should not be used as an expedient to comply with the regulations, which state that junctions must be made 'obliquely in the direction of flow'.

When a new drain is to be connected into an existing drain it should always be done in a manner that will allow maintenance and testing to be carried out easily by either using a simple junction within 12.5 m from an existing manhole, or by providing a correctly-designed new manhole.

Note

1. All junctions should be made using 45° fittings oblique in the direction of flow without the device of inserting an acute bend just before the actual junction;
2. To prevent cross flow between junctions, double junctions should not be used.

Many manufacturers' catalogues, used by some designers as design detail sheets, show inspection chambers containing acute bends prior to the through pipe or fitting; this method of making a junction between drains should be avoided.

Drainage survey 1976-77

During recent surveys carried out in health care buildings throughout the country, it became obvious that a considerable proportion of blockages are still occurring in manholes and inspection chambers.

The guidance information given in this paper is based upon this survey and accepted good practice.

There are various reasons why such blockages are occurring, but to generalise they are due to two basic factors. Firstly, the type of effluent; hospital waste unlike domestic waste contains much more solids such as paper towels, papier-maché and macerated waste (although the use of paper towels and so-called disposable internal menstrual tampons, etc are causing increasing domestic drainage blockages, particularly in older property). Secondly, the old drainage systems were not designed to cater for such effluents and in some cases the pipework, fittings and materials are unsuitable. Too often in an old hospital the drain from a sluice appliance which has functioned adequately for many years will start to give trouble after up-grading of the building includes the installation of bedpan macerators. If this type of equipment is to be used the associated pipework and manhole systems must be checked for suitability.

Fig. 7. Blockage forming on benching.

Figure 7 shows a classic blockage developing. Paper, etc, discharged into a branch drain has crossed the main channel within the manhole and lodged on the benching. When sufficient solids have accumulated it will fall back into the main channel, float down to the outlet pipe and block. In no time the manhole will be full of effluent which will back up the main drain, and, depending upon the depth and complexity of the underground system, it will not become apparent until effluent is observed, possibly within the building.

Figure 8 shows a manhole blocked with papier-maché from bedpan disposal units. On each of four floors in a very old building a new macerator had been connected into an existing external discharge stack, which entered an old manhole. Consequently, the manhole continuously became blocked as it was not designed to take this type of effluent.

Figure 8. Manhole blocked with paper maché.

Figure 9. Manhole blocked with paper towels.

This type of blockage will occur within new manholes as well as old. Paper towels are discharged into the system, pass around the trap of the WC, through the stack junction and into the stack, where they are constricted by the bore of the pipe. When they enter the open channel within the manhole they expand and therefore will not leave the outlet. Depending upon other factors, such as the quality of the manhole, number and type of towels entering the system, etc, blockages will continually occur.

Design guidance – manhole construction

Based upon the above survey the following recommendations should assist in eliminating or at least reducing the number of blockages occurring.

Where blockages occur regularly, consideration should be given to the total reinstatement of the pipework system within the chamber and/or the complete chamber. It is estimated that the total cost of clearing a blockage is a minimum of £20; to reinstate an average manhole will cost £200-300. Therefore, the capital cost for once-weekly clearing can be recovered in 10-15 weeks. It is therefore recommended that manholes — particularly those under one metre in depth, that continually become blocked should be reinstated.

Blockages within pipework systems are caused by the roughness of the pipe and fittings, coupled with jointing systems that do not accurately align joints between individual items. Only smooth bore pipework and fitting, and a jointing system manufactured to engineering tolerances, should be used. If it is considered necessary to use a cast iron system, each part of the system should be inspected for roughness and rejected if necessary. The specification of materials must state the condition of the material to be used.

Channels should not be used, but the pipework should pass through the chamber with appropriate access doors. Side junctions into the main pipe must not be positioned diometrically opposite each other, or return at more than 90° to the flow. Where possible, 45° oblique junctions should be used.

It is important that the walls of the chamber are water-tight. This can only be achieved by using 225 m Class B engineering brickwork or sealed concrete rings properly constructed, and if necessary backed by concrete. If it is considered that ground water may enter the chamber via the walls, provision must be made to drain the chamber, or access to the maintenance points could require a diver's suit.

It will be found that using the above technique only a small number of junctions can be contained within a standard manhole. If additional junctions are required, they should be made outside the chamber, with rodding points placed at the head of the branch just before the discharge stack. For external stacks access can be on the base of the stack, but for internal stacks they are better sited outside the building.

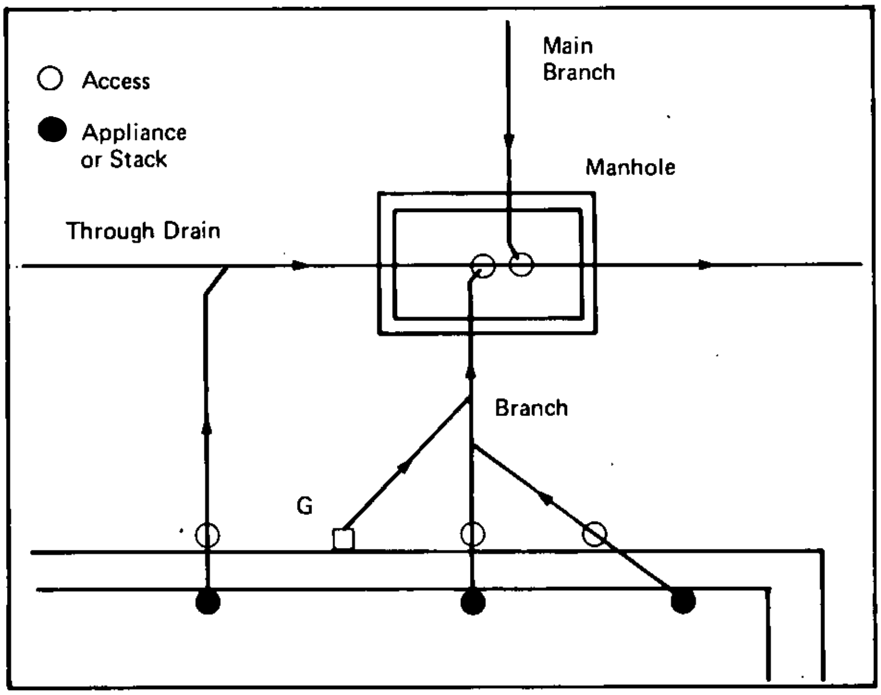


Figure 10. Example of sealed pipework system.

Conclusions

The design recommendations outlined within this paper are not appropriate for systems that will be maintained by staff using traditional cane rods, but if this technique of manhole construction, coupled with good drain installation is adopted, it may not be necessary to clean the system at all.

This informal paper was prepared in 1976 by Medical Gas Installations Ltd. for hospital engineering staff in response to the many enquiries the firm had received for information on waste anæsthetic gas systems. The paper gives a good basic grounding in the subject, although in so rapidly developing a field, it does not necessarily cover the most recent developments.

Waste Anæsthetic Gas Systems

The paper has two aims: One is to provide information on the 'State of the Art' so that an engineer has enough background to know what questions to be asking. The other is to show how each installation needs to be tailored to suit its present and future requirements, and the factors to be taken into account.

We must stress that this is a Company paper, offering information in line with the current national and international standards affecting waste gas systems, which are in the course of preparation. These standards have settled to the extent that we can offer this information, but they are still liable to change. For this reason we have avoided the use of figures, which may easily be changed in a final standard. However, enough information is available to design a fixed system which will accommodate any likely change in the standards.

Background

Early work on waste anæsthetic gas systems was predominantly clinical, treating the patient as the sole source of supply of contaminated gas, and evaluating acceptable pressure limits for a waste gas system which could be imposed on the patient in relation to the various anæsthetic circuits.

Some medical abnormalities — such as spontaneous abortion — have been shown to be statically high among staff who work in operating theatres, and a relationship between these abnormalities and exhaled anæsthetic gas present in an operating theatre has been considered.

The Health and Safety at Work Act 1974 lays a duty on the employer to provide and maintain 'a working environment for his employees that is, so far as is reasonably practical, safe, without risks to health, and adequate as regards facilities and arrangements for their welfare at work'.

For practical purposes, this duty has over-ridden the medical discussion on the relationship between health and waste gas, because unless it can be shown that there is *no* risk, the duty remains.

Guideline information on the performance of waste gas systems which has previously been issued, has tended to reflect this earlier medical and statistical research, and concentrated on the performance of systems in relation to patients in operating theatres.

However, if it is accepted that under the Act exhaled breath contaminated with anæsthetic gas is not acceptable, then it can be recognised that there are a number of other sources of waste gas which can discharge into the atmosphere, and these may not be in the operating theatre.

As an example, consider nitrous oxide, an anæsthetic gas which is intended to be inhaled — and therefore exhaled. So any room which has a N20 medical terminal is likely to have waste gas present if that point is used. As N20 terminals are installed in intensive care units, coronary care units, etc, a wider range of equipment may be involved than that used solely in operating theatres.

This has caused a recent radical change in thinking on waste gas systems.

There is a range of respiratory equipment which acts as a reservoir of exhaled gas, and this equipment is often operated by mechanical means. The equipment may accept the gas at a rate appropriate to the discharge from the patient, but may be able to discharge its own contents at a much higher rate — possibly that of its internal pump.

So any waste gas system must be capable of handling, not only the relatively low flow from the patient himself, within certain pressure limits, but also any emergency dump from ventilators etc. As an indication of the sort of factor to take into account, one piece of pulmonary equipment discharges its waste gas so that it mixes with the driving gas, and can give a total discharge of 150 litres/min.

There are two types of system — the passive system and the active system — which are described in greater detail below. In general, an active system will be required where there is any equipment which can discharge a large volume of gas.

The passive system

The passive waste gas system is an open length of tube which connects the patient directly to the outside air. The system has flexible tubing from the respiratory exhaust valve at the patient, and connects to a wall point. A length of rigid piping conducts the waste gas to the outside.

The passive system has no air-moving equipment, and relies on the pressure differential between the exhaled air from the patient and the outside air, to drive out the gas. The system becomes, in effect, part of the patient's breathing system, and the system must be designed **as a whole,** taking into account both the flexible and fixed part of the system. The system must be designed within certain clear performance limits to avoid over- or under-pressure in the pipework.

Over-pressure means that the resistance to flow in the pipework is too high, and the patient has difficulty in breathing against it. At the worst, over-pressurisation can have a serious effect on the patient. At the best, a relief valve in the circuit will operate, so that the exhaled breath is discharged into the operating theatre — thus defeating the purpose of the installation.

The main cause of over-pressurisation is too high a pipeline resistance because the pipeline is too long, or the bore too small in relation to the flow required.

Another cause is that the layout of the pipeline is too complex, bearing in mind that each change of direction, and extra fitting increases the resistance to flow.

Another is that the discharge end of the fixed pipeline is situated in an area, or is of a design, which admits draughts to the pipeline.

A further cause may be that the resistance of an otherwise acceptable system may be increased by additions. This is unlikely to happen to the fixed part of the system, but a theatre technician may consider it reasonable to extend the flexible part of the system by adding a few metres of hose to meet a particular situation without fully realising the effect on a carefully designed system.

Under-pressure happens when suc-

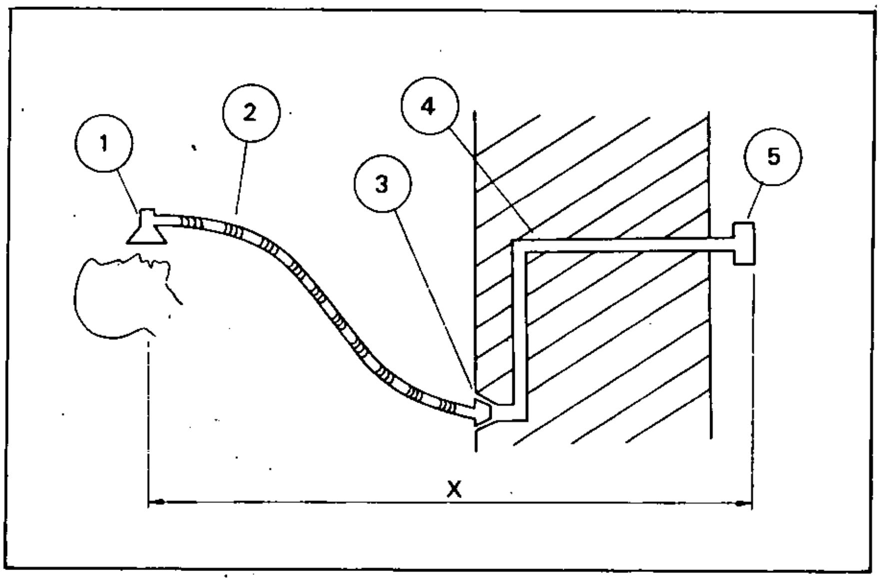


Figure 1. The passive system.

This schematic layout of a passive system shows that it is basically a pipe connecting the patient to the outside atmosphere, and leading the waste gas away from the working area.

The face mask (1) incorporates an expiratory valve so that the exhaled breath is spilled into flexible hose (2). The hose is connected to the rigid pipework (4) with a 30mm taper connector (3). The fixed pipework terminates with a suitable protective outlet (5).

The system must be designed so that maximum and minimum pressure limits are not exceeded over length 'X'.

Attachments such as water traps, safety valves, expansion bags, etc., are not shown, but must be taken into account in estimating the pressure drop.

tion in the system increases beyond a certain limit, which can put suction on the patient's lungs. The main cause of under-pressurisation is the flow of air past the end of the discharge pipe. This causes a venturi effect which draws air from the pipeline and reduces the pressure. This effect can be reduced by careful design of the discharge point. A straight stub-pipe outlet is suspect. A number of designs of discharge configurations are available which can reduce this effect. Another way of reducing the effect is by careful siting of the discharge point. Not only must it discharge the exhaust gas into a safe area, but the area must be unlikely to have any bad suction effects.

An obvious example of poor siting would be on the external wall of a high-rise building. These are usually notorious for wind problems. However, even an apparently sheltered area may be subject to eddies and vortices which can cause serious local winds near a discharge point.

All these factors can be taken into account, but a survey is needed to recognise them, and for the detailed calculations necessary.

A number of Rule of Thumb formulæ are available — particularly for the pressure resistance of pipelines. These are usually adequate for the purposes for which they are normally used, but our experience is that the margin of error in these overall formulæ is too wide for the somewhat precise limits of performance required for a passive system.

Practical considerations

For the smaller operating theatre, where the patient is the only source of contaminated air, a simple passive system would appear most suitable, comprising a flexible hose from the patient expiratory valve to a 30mm male taper connection, which fits a 30mm taper outlet point as the start of a length of fixed pipe to the outside.

However, there may be a limited number of suitable sites for the outside discharge point, and these will tend to dictate the length of pipeline and its configuration. When the fixed pipeline and the flexible pipeline are taken into account, the pipeline resistance may be too high.

A more direct route to the outside may be found, and this will help by reducing the pipe length, but generally in these circumstances a larger pipe bore must be used. The likely initial choice of pipe bore will be 35mm nominal, but at this range of pipe diameters, the step to the next size of pipe becomes increasingly greater, and this is reflected in the cost of the pipe. Once it is conceded that larger pipe diameters than 35mm are to be used, the cost will increase at such a rate, that some other system than a passive may be the most economical way of clearing the waste gas.

Pressure limits

The pipeline will be designed to be within a specified range of pressure resistance at a specified flow rate, though a number of other factors must be allowed for within those limits.

The dangers of over- and under-pressurisation have been mentioned. One waste gas terminal point provides additional protection by incorporating a positive and negative relief valve to ensure that the pipeline operates with the limits, but it must be stressed that these are to protect the patient, and are not a substitute for a correctly designed system.

If pressure increases abnormally in the pipeline, the relief valve operates to prevent the pressure being placed on the patient, and the excess gas is discharged into the theatre.

If the pipeline is incorrectly designed so that the resistance is inherently high, the relief valve will be operating frequently. The patient will be safe, but the fixed pipeline will be redundant, and gas will be regularly discharged into the working area. This is unacceptable as a permanent feature of the installation.

Similarly, the negative pressure relief valve recognises that a discharge point which is normally safe, may be subject to unwanted venturi effects such as may occur during a freak storm. Its presence is not a substitute for a good design of discharge point in a suitable location.

Hygiene

The patient is exhaling moist saturated air at body temperature. When this reaches the fixed system it passes into a pipeline which is at the temperature of the building fabric, and will become progressively cooler as it nears the outside of the building. Moisture will condense in the pipeline, and arrangements must be made to accommodate this condensate. Some wall outlets incorporate a removable sterilisable bottle to catch the condensate.

A fall must be incorporated into the pipeline during construction, to avoid stagnant condensate. In a simple system, the bottle at the terminal end may be adequate for the system. In a complex system, secondary bottles may be needed, and special arrangements may have to be made to make the bottles visible and accessible.

Sterilisation

The fixed pipeline incorporates sterilisation points at appropriate places in case the pipeline needs to be sterilised.

Cross-infection

Each room should have its own fixed pipeline system to prevent the risk of cross-infection.

The active system

The active system consists of a passive system to a collecting vessel. This is then evacuated by positive suction.

The need for the active system has arisen for two main reasons. One is that the practical limitations to a completely passive system may prevent its use, even if it were the first choice. This would arise where the source of supply of the waste gas was too far from the exterior of the building, causing too high a flow resistance in the pipeline. The other is the recognition that there are other sources of supply of the waste gas than the patient — the gas may be held in a reservoir, or provide the driving force for some anæsthetic equipment.

It is often necessary to discharge this gas rapidly, with relatively high gas flows over a short period. If this gas is dumped into the theatre, the advantage of having a waste gas system is lost. If it is discharged into the exhaust line which carries the patient's breathing, the large volume of gas can cause a pressure build-up which could be hazardous to the patient.

The likely standard will require a hose from each source of supply of waste gas, to a collecting vessel which is open to atmosphere. Each source will have its own hose, and the collecting vessel will have the facility to accept a number of these hoses. The source of the gas may be the patient, whose exhaled breath will be taken down one hose. A piece of anæsthetic equipment may be another source, connected to the collecting vessel by its own hose, and so on.

A number of hoses will be in parallel so that an excess flow of gas in one will not affect the others. The outlet of each source of supply will have a 30mm ISO male taper. The hose — officially called the 'connecting part' will have a 30mm female taper inlet and a male outlet.

The collecting vessel will have 30mm ISO female sockets for accepting the connecting part. The collecting vessel is connected to the fixed pipework, which incorporates an air mover, so that the waste gas which passes into the vessel is extracted.

The performance parameters of the system will be defined from the source of supply of gas to the collecting vessel as a specific resistance in cmH_2O for a given flowrate.

Relief valves will be fitted to each hose line.

Thus the active system may be considered as several passive systems in parallel, each with closely defined parameters from the source of the gas to the collecting vessel; and a fixed pipework system which is required to move the gas at a suitable rate from the vessel. The vessel is open to atmosphere, so that the suction in the fixed pipework cannot be placed on the patient's lungs. However, an abnormal excessive gas flow, which is beyond the capacity of the system, will overflow from the vessel with no harm to the patient.

The size of the vessel will vary with the requirements of the situation. If the rate of extraction equals the maximum demand likely to be placed on the system, the vessel can be relatively small, but the extractor pump will be oversized for most of its working use. If the vessel size is increased, the size of the pump can be reduced, and its selection becomes an economic factor in the design of the system.

At first sight, the active system has some attractive advantages over the passive system.

The passive system is subject to performance parameters over its whole length, much of which is fixed and not suitable for alteration. So if a passive system is wrong it tends to be permanently and expensively wrong. In the active system, the performance parameters are from the gas source to the collecting vessel. This is mainly flexible hose, and can be easily adjusted and altered. The fixed part of the system would appear to be limited in its design requirements to the ability to remove a suitable quantity of the gas.

Taking into account the possible extra requirement for respiratory equipment in the future — as yet unknown — and the possible need to upgrade any system, the active system has the flexibility to accommodate future demands. However, the active system raises some interesting practical considerations for design and installation.

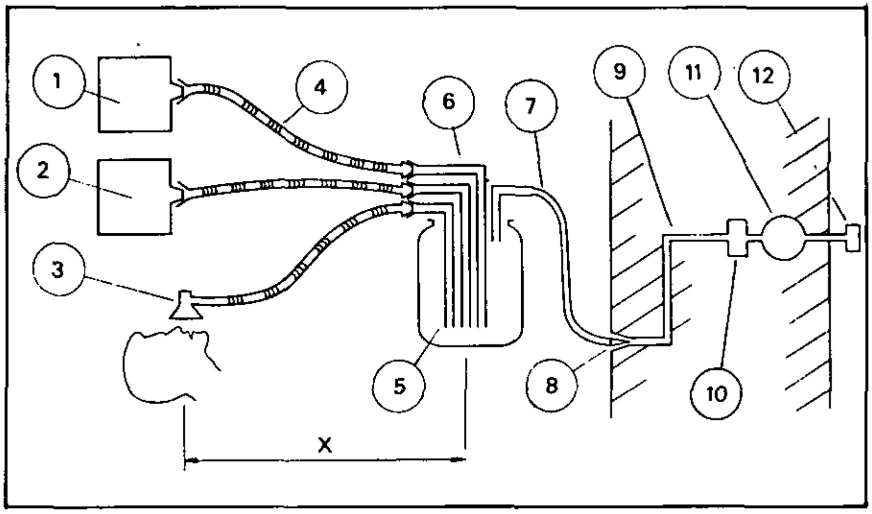


Figure 2. The active system.

This schematic layout shows that the active system is basically a passive system which terminates in an open reservoir, the contents of which are actively actuated.

A number of pieces of equipment (1), (2) can be connected into this system, as well as the patient's face mask (3) which incorporates an expiratory valve.

The waste gas is discharged through hose (4) into the reservoir (5). The hoses are connected to the reservoir head (6) which can accept several hoses and has provision for closing off those inlets not in use.

The gases are extracted from the reservoir through hose (7) which can be connected to the outlet point (8). The gases pass through the rigid pipework (9), extracted by the mover unit (11) to a suitable discharge point (12). The fixed pipeline may include a bacterial filter (10).

The system must be designed so that the pressure drop over length 'X' is maintained within positive and negative pressure limits. The layout of the room will dictate the relative lengths of hoses (4) and (7).

Although shown as a wall unit, the outlet point (8) can be a pendant or boom-mounted unit.

Practical considerations

The standard will probably require discharge ports from respiratory equipment to be 30mm ISO male tapers; and if there is more than one port, each must be fed separately to the collecting vessel. The performance over that length of hose will probably be specified as a maxumum/minimum resistance at a flow rate — and this will be relatively low, in line with normal breathing rates. However, some equipment can discharge waste gas at rates up to 150 litres/min.

The manufacturers of respiratory equipment must know the back-pressure against which the equipment is to discharge. At present, this is atmospheric. When the standard is published, it will be a revised figure, but standard.

In the absence of this standard figure, a piece of anæsthetic equipment may have one performance when discharging into a long small-bore pipe, and another when discharging into a short wide-bore pipe. This leads to the main design difference between a medical gas pipeline, and a waste gas system.

The medical gas system is designed to give a specific performance at the wall outlet, whereas **for design purposes**, the waste gas system begins at the entry to the connecting part, which is considered as the start of the 'fixed system' even though it is obvious that all the flexible installation inside the room can be disconnected and dismantled.

The reason for this lies in the definition of the performance of the system as being from the entry to the connecting part to the collecting vessel, and can be shown by two examples.

At one extreme, consider a small, low-demand installation being fitted in a small room, as an active system. The only source of waste gas is the patient. The collecting vessel may be attached to the wall, out of the way.

The performance requirement of the system may be so low that for practical purposes, you could have **any** length of hose from the patient's discharge valve to the connecting vessel, and still be within the performance limits of the system. This would be particularly helped by the small room, and the short distance from patient to wall.

At the other extreme, consider a large room, with not only the patient, but ventilators and other equipment with a potential high discharge rate.

To stay within the standard back-pressure limits, it may be that the maximum length of hose which can be attached to each machine will be, say two metres, but the wall may be four metres away. In this case, the reservoir vessel must be brought into the room to where the specified lengths of hose can be connected, and there must be some further length of hose from the collecting vessel to the permanent wall point of the rigid system. The vessel may be attached to some piece of convenient equipment in the room — such as a Boyle's machine — or it may be on a movable boom, which can be moved to suit particular circumstances. The size of vessel required may influence this choice. Also, the length of flexible pipe from the vessel to the wall point must be taken into account when designing the system.

This reflects the point that the system must be designed **as a whole.** By treating the connecting part as part of the fixed system, the location of the collecting vessel can be defined, and the hose back to the wall can be supplied as part of the total system.

A hospital's difficulties can be appreciated if it takes over a fixed active system which ends at the wall, but does not realise that it has been designed for a specific length of hose to the collecting vessel. The actual system which is connected to the terminal may be inadvertently unsuitable for the application. The requirements for the fixed pipework for an active system are different from those for a passive system.

There must be no risk of anyone accidentally plugging the patient's hose into an active terminal point with suction, in the belief that it is passive. Hence, the 30mm taper points cannot be used at wall points

Anæsthetic vapours which may be present in the exhaust gases present certain factors which must be taken into account in the selection of an air mover. The gases may be inflammable, explosive or corrosive to certain materials, and the materials used in the construction of the air mover must be suitable.

Special consideration must be given to the sizing of the air mover, which depends on the circumstances of the installation. One view on sizing is that if the system will incorporate respiratory equipment which can discharge at a known rate, and if the extraction device, in conjunction with the storage capacity of the collecting vessel, has a draw-off rate of less than this, then there will inevitably be a discharge of gas into the working area.

While occasional minor discharges of waste gas in infrequent emergencies may be tolerated, from equipment such as relief valves, it is unlikely that foreseeable overspill from the dumping of quantities of gas would be considered acceptable. Even if the hospital does not use equipment with high discharge rates now, it may do so in the future, and this should be taken into account.

The selection of the air mover is a practical and economic decision. Looked at strictly as vacuum, a pump to move the large volumes of air at the low suction, tends to be expensive. A diaphragm pump overcomes the problem of material suitability but these pumps are generally very good value for providing high suction on small volumes of air, and they may not be the best economic solution for a waste gas system which requires larger volumes of air at low suction.

Other methods of moving the air are available. A venturi-type pump can move the large volumes of air required, but these pumps are usually rated with an atmospheric inlet and outlet. Fitting such a pump into a pipeline with pressure loading both upstream and downstream will affect the rated performance. In addition, a bacterial filter will probably be required between the pump and the installation, and this must be taken into account in the performance. For the installation of the pipework, similar considerations apply as for the passive system.

Condensation is likely to occur, though this may be helped by a water trap in the pipework before the air reaches the wall.

Dilution of the waste gas will occur in the collecting vessel, and this will also help. Nevertheless, drainage traps will probably be needed in the fixed system, and a suitable fall will need to be incorporated into the pipework.

Other methods of discharge

Two other methods of removing the waste gas have been proposed. One is to use the medical gas pipeline. This is not recommended for reasons discussed below. The other is to discharge the gas into a suitable air-conditioning duct.

We would advise against this latter for four main reasons: (i) a known rate of removal and performance is required, and this cannot be accurately calculated from the induction into one leg of an air-conditioning system; (ii) waste anæsthetic gases may damage moving parts of the air system; (iii) the air may be recirculated; (iv) the legitimate alteration of the air-conditioning system, even in an area unconnected to the operating theatre area, may alter the performance in the theatre without warning.

Medical vacuum

There is a tendency to assume that the fixed system of an active waste gas system is similar to the medical vacuum system, and this is not so. The medical vacuum system is designed for relatively low flow, with high suction, the level of which vapourises moisture and is deleterious to organisms. The waste gas system is simply required to move known quantities of air, and high suction is not required. It is more akin to dental suction than medical vacuum. If the waste gas is discharged into the medical vacuum system, the gases may damage the expensive vacuum plant which has not been designed to accommodate them. There is also the risk of relatively high suction being placed accidentally on the patient.

Testing

We would recommend that a flow/pressure test be applied to each installation before handover. This provides a base line against which any possible deterioration of the system can be measured.

Such tests would bring the installation into line with medical gas installations and dental vacuum systems, which require performance tests as specified in HTM22 and the appropriate British Standards.

Considering how the performance of a waste gas pipeline can have a direct effect on the patient, it could be less than prudent to plug him into a fixed system whose performance has only been calculated or estimated.

What can be done now?

Enough design information and suitable equipment is available to enable a waste gas system to be installed. The key component is the patient expiratory valve, as without this, the anæsthetic circuit cannot be tapped to remove the waste gas. Most manufacturers of these valves have introduced a model with a waste gas discharge port, and these have been in use for some time.

Most manufacturers have other equipment for waste gas systems in the operating theatre in the prototype or reproduction stage. These include line relief valves, reservoirs, brackets for supporting the vessels, etc.

The absence of this equipment does not prevent the installation of a satisfactory system now, but means that future equipment will be available for increasing the sophistication of the flexible section if required.

The fixed system can be installed now, subject to two provisos (i) that its performance is adequate; (ii) that its performance is **known.**

This latter point is particularly important. There may be future changes in breathing circuits, anæsthetic equipment, etc, which can be easily and economically introduced by changing the flexible pipework. If the resistance of the new system and its components is known, and the resistance of the fixed pipework, it can be ensured that any new system is within acceptable limits. If the performance of the fixed system is not known, *it will be possible to overload* it with new equipment without realising.

The terminal point can be fitted to the wall as a flush or surface mounted unit. One terminal point available has a compartment beneath the connection point containing a bottle condensation trap. The compartment is ventilated and incorporates a positive/negative pressure relief valve. The passive unit incorporates the 30mm taper connection. The active terminal has a different connection to ensure that the passive system cannot be inadvertently connected.

The wall terminals are standard items which can be connected to new or existing buildings. The terminal point and drain trap can be fitted to new hose booms and pendants, being incorporated in the design, but it is unlikely that existing booms and pendants can be modified unless provision has been specifically made for a waste gas system.

The details of installation are a matter for discussion at each site.

The passive system will require a large bore pipe. This will require a large wall chase if the terminal is to be kept flush, and will leave a large pipe exposed for a surface installation. The former may not be acceptable, where, say, the wall is tiled, and cannot be chased without substantial damage. The latter may not be acceptable in, say, an operating theatre. However, we have used techniques for cutting out walls to take pipelines which cause minimal damage, and devised other techniques.

One of these uses special rear-entry medical gas terminals, so that a terminal can be flush in one room, while its supply pipe is taken through the wall and up the other side, avoiding the use of chases where surface preservation is important. These are cases where the expertise developed for the installation of medical gas pipelines can be simply transferred to waste gas systems.

For an active system, the pipe can be smaller, but is not likely to be less than 22mm, bearing in mind the requirements of HTM22 for medical vacuum compared with the low resistance system for waste gas.

The actual pipe sizing and routeing will depend on the method of airmoving which is selected.

The wall terminal would normally be located at low level. It is possible that this may not be acceptable, because it requires one more trailing hose on a floor which is already congested. To overcome this, a standard ceiling pendant is available. This accommodates only the waste gas connection with the drain trap, and may be considered an alternative to the wall point. The active air mover is controlled by a switch or pushbutton near the usage point of the waste system with an indicator light to show that the system is active. The exact location of these is a matter for discussion on site. A range of passive discharge points is available — inverted tees, H outlet, double cone, etc.

Book Reviews

The Energy Manager's Handbook

The Energy Manager's Handbook
by: Gordon A. Payne, 148pp.
Published by: IPC Science and Technology Press, 1977.
Price: £7.50 (cloth covers), £4.75 (paper covers).

Could Gordon Payne have launched his handbook at a more opportune time? I think not. Particularly relevant to the energy climate of today is the question of the full-time role of the Energy Manager.

Clearly the nation now sees the need for energy conservation as vital to our future wellbeing. However, it will not happen overnight or by itself, a trained and highly skilled person must be used if success is to be achieved.

This handbook, so well presented, illustrated and beautifully printed at a reasonable price must surely be a ready tool to enable the Energy Manager or Engineer to carry out his task more effectively. It is designed to provide in a single publication sufficient guidance for the reader to generate and sustain a straightforward energy conservation and audit programme tailored to his own particular needs.

One particularly likes after each paragraph section the idea of including bold type comprehensive check lists of duties and requirements.

Clarity and simplicity in the best possible sense is the hallmark throughout, and not least of all in the final three appendices covering unit and conversion factors, test equipment, and further reading and reference list.

There is no doubt that this handbook explains the essentials in straightforward non-technical terms to help the reader develop a practical and systematic approach to energy management.

RGS

Product News

Compact Alarm System

Dougal is the familiar name of the small modular Alarm Annunciator system designed and produced by Highland Electronics Ltd., in their Scottish factory.

Just a year since the introduction of the AR20 series of Alarm Annunciators, Highland announce another addition to this 'Dougal' range with four alarm circuits only and in a 10½ inch wide presentation instead of a 19 inch format.

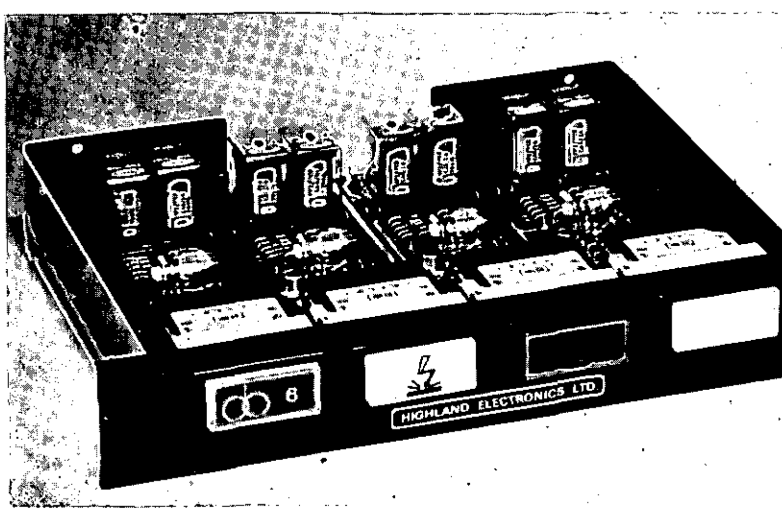
This space saver Alarm module incorporates all the features and technical advantages of its 'bigger brother' and again achieves the highest degree of reliability at low cost by combining proven circuitry with modular building techniques.

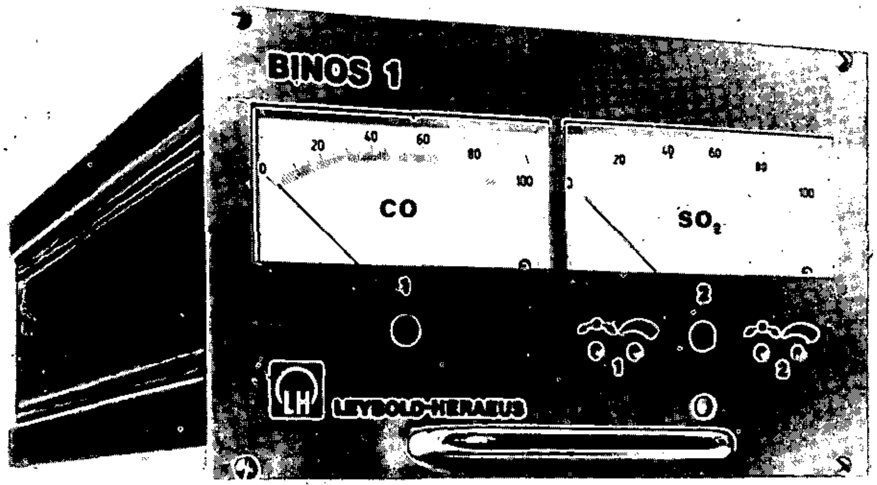
The unit is protected against transients of up to 5 kV, accepts mains voltage fluctuations of minus 20% plus 10% and works from normally open or normally closed initiation contacts.

Four-way Dougal Units are primarily designed for applications where a limited number of Alarm points are required and the available display space is at a premium. Where space permits up to six units may be stacked to provide up to 24 independent alarms.

For further information contact: *Highland Electronics Ltd., Highland House, 8 Old Steine, Brighton, Sussex BN1 1EJ.*

The new addition to the 'Dougal' range of alarm systems.





New Infrared Continuous Gas Analyser

Leybold-Heraeus has developed a new infrared gas analyser which will interest automotive engineers, environmental chemists, factory inspectors and intensive-care units. A non-dispersive IR photometer, the BINOS 1 can measure two components of gas simultaneously and independently. There must be at least two different atoms in the gas molecules, such as CO, CO_2, H_2O, SO_2, NO, NH_3, CH_4, C_2H_4, C_3H_8, or C_6H_{14}. It can also measure organic substances such as solvent vapours and fluorocarbons. Leybold-Heraeus say that it measures gas and vapour concentrations quickly, selectively and continuously, in both ppm and volume per cent ranges.

Leybold-Heraeus has considerably improved the infrared photometry by means of a new ultra-fast microflow detector that enables modulation frequencies of 250 Hz to be used. The capsuled eddy-current-driven chopper not only creates the signal modulation, but also continuously provides automatic sensitivity checks and corrections at approximately 3600/minute.

Advantages that result include: long-term stability of sensitivity by electronic self-regulation, no calibration gases are usually needed for readjusting instrument sensitivity, and the indicated value is not influenced by outside vibration.

Two completely independent units can be supplied, if required, mounted side by side in a single case. A switching circuit (supplied as an option) can be pre-set to energise alarms, recorders, exhaust fans, etc., at certain levels of detection.

The long-term stability makes this analyser most useful for gas atmosphere control in industrial furnaces and chemical process plant. It is also most useful for detecting and measuring pollution gases from industrial processes, and engine exhaust gases. One of the first medical applications has been to measure carbon dioxide concentrations in the breath of coronary patients under intensive care.

Binos 1 varies in price from approximately £1,700 to £4,500 depending on the number and complexity of components to be measured.

Further information: *Leybold-Heraeus Ltd., 173 Greenwich High Road, London SE10 8JA. Telephone: 01-858 1127.*

Classified Advertisements

APPOINTMENTS AND SITUATIONS VACANT

MERTHYR AND CYNON VALLEY HEALTH DISTRICT

Assistant Hospital Engineer

PRINCE CHARLES HOSPITAL

The Prince Charles Hospital is a new District General Hospital of 364 beds, which is due to be commissioned in early 1978. We wish to appoint the Assistant Engineer who will assist the Hospital Engineer in managing the total engineering services of the hospital. The Assistant Engineer will have an initial involvement in commissioning the plant and equipment which includes steam boiler plant and partial site generation of electricity.

Applicants must have completed an apprenticeship in Mechanical Engineering or have otherwise acquired a thorough practical training appropriate to the duties of the post. Should hold ONC in Mechanical Engineering or an alternative acceptable qualification.

Preference will be given to those with relevant hospital experience.

Salary scale: £3,063-£3,507 pa, plus Phase I and II Supplement to Earnings payable, ie £291 pa plus 5% of total earnings — maximum of £4 per week. (New entrants to the NHS may be eligible to start at £3,285 pa in respect of relevant experience since the completion of practical training).

Application forms and job descriptions available from: **Mr Tudor Smith, District Administrator, District Headquarters, St Tydfil's Hospital, Merthyr Tydfil, Mid Glamorgan.**

Closing date: October 21, 1977.

Mid Glamorgan Health Authority

Avon Area Health Authority (T)

Frenchay District

ASSISTANT ENGINEER

required for Frenchay Sector to assist the Sector Engineer in the operation and maintenance of the engineering services of the Hospitals.

Applicants should have served an apprenticeship in electrical or mechanical engineering and possess an ONC in engineering or equivalent qualifications acceptable to the Secretary of State.

The post offers excellent experience in Hospital Engineering in a busy Acute District Hospital.

Salary scale: £3,063 pa - £3,507 pa, plus £312 pa non-enhanceable payment, together with Phase II pay award. There is a bonus scheme in operation.

Application forms may be obtained from the Personnel Department, Frenchay Hospital, Bristol. Telephone: Bristol 565656 extension 578.

Closing date for completed applications: October 28, 1977. Only shortlisted candidates will be contacted.

Directorate of Community Services

MAINTENANCE MANAGER – BATHS

£5,124-£5,427 plus £520 supplement

We need an experienced maintenance engineer to be responsible for the day-to-day control of direct labour engaged on maintenance of our baths establishments and supervision of contract work.

Duties will also involve the initiation and control, through a team of maintenance engineers, of a system of planned preventative maintenance.

Applicants (male or female) should hold a National Certificate in Mechanical/Electrical Engineering or equivalent and should have served an indentured apprenticeship and have several years' practical experience.

A current driving licence is essential.

Application form from Personnel Services, Town Hall, Patriot Square, E2 9DN, or telephone 01-981 0077 anytime, quoting ref. 10/3. Closing date: 24.10.1977.

LONDON BOROUGH OF TOWER HAMLETS

BURY ST EDMUNDS HEALTH DISTRICT

(Suffolk Area Health Authority)

ASSISTANT HOSPITAL ENGINEER

Bury St Edmunds

£3,843 - £4,355

to be based at the West Suffolk Hospital, but with special responsibility for other health service premises within the Bury St Edmunds area.

The person appointed will assist with the day-to-day operation and maintenance of the building and engineering services.

If you have an ONC in Engineering or equivalent qualification, have a thorough practical training in mechanical or electrical engineering and proven managerial ability, then contact the District Personnel Officer, Bury St Edmunds, Suffolk IP33 3NR. Telephone Bury St Edmunds 63131 Ext 866, for a full job description and application form.

Closing date for receiving applications is October 24, 1977.

To place an advertisement in the next issue of *HOSPITAL ENGINEERING*, appearing on *November 4, 1977*, please contact: *EARLSPORT PUBLICATIONS*, 17 St Swithin's Lane, London EC4, 01-623 2235/8, by *Tuesday, October 25, 1977* latest.

Bahrain

Bahrain's central position in the Gulf, and the constant availability of fresh water have made the island a natural trading and commercial centre throughout the ages. Today Bahrain is a thriving industrial nation and a wide variety of major projects in both the public and private sectors are being undertaken.

To keep pace with this progress, the State's comprehensive and free medical services are also rapidly expanding, and the following opportunities are now open for qualified applicants who are willing to contribute to an exciting stage in Bahrain's growth and development. Generous tax-free salaries and other benefits are offered, and a wide range of sporting, social and leisure activities are available in the State.

The Salmaniya Medical Centre requires maintenance engineers to assist in the running of a 600 bed fully-equipped hospital.

Plant Engineer

To be responsible for the organisation and direction of the maintenance group and the development and implementation of maintenance programmes.

Candidates, under 50, must have HND or a degree in technical or electrical engineering. They should also have at least 10 years' experience in the maintenance of mechanical and electrical plant and equipment, and should have held responsible positions supervising maintenance programmes. Applicants must have had management or supervisory training and administrative experience. Experience in hospital maintenance would be an advantage. (MT/606/HD)

Mechanical Engineer

To supervise technicians and tradesmen engaged in the maintenance of all types of mechanical equipment. He will carry out day to day administration and training of his personnel and implement maintenance programmes for the mechanical equipment.

Candidates, under 40, must have HND or a degree in mechanical engineering. A minimum of 7 years' experience in the maintenance of mechanical equipment is essential, including boilers, calorifiers, pressure vessels, compressors, generators, incinerators, pumps and general medical services. Applicants must have held supervisory or managerial positions, and experience of hospital equipment would be advantageous. (MT/607/HD)

Electrical Engineer

To supervise technicians and tradesmen engaged in the maintenance of electrical equipment, and be responsible for the administration and training of personnel. He will also implement maintenance programmes for electrical equipment.

Applicants, under 40, must have HND or a degree in electrical engineering. A minimum of 7 years' experience is required in the maintenance of electrical equipment including motors, starters, switchgear, generators, rectifiers, industrial instrumentation and control and distribution systems. Candidates should have held supervisory or managerial positions. (MT/608/HD)

Air Conditioning and Refrigeration Engineer

To supervise technicians and tradesmen engaged in the maintenance of air conditioning and refrigeration equipment. He will be responsible for day-to-day administration, the training of personnel, and implementation of maintenance programmes for air conditioning and refrigeration equipment.

Candidates, under 40, must have HND or a degree in electrical or mechanical engineering. A minimum of 7 years' experience is required in the maintenance of large air conditioning and refrigeration units and air handling units. Applicants must also have held managerial or supervisory positions, and experience of hospital equipment would be an advantage. (MT/609/HD)

The commencing salary for all posts will be equivalent to £9380 pa including terminal gratuity, and is tax-free.

Benefits include free family passages, generous paid leave, children's holiday visit passages and education allowances, free housing, settling-in allowance and free medical attention.

For full details and application form write quoting appropriate reference to:

Crown Agents

The Crown Agents for Oversea Governments and Administrations, Appointments Division, 4 Millbank, London SW1P 3JD.

West Sussex Area Health Authority
WORTHING DISTRICT
Works Department

Senior Electronics Technician

(Grade 3)

Candidates should have a broad experience in this field and have a minimum of ONC or equivalent qualification in electronics.

This post provides interesting work of a practical nature, in the maintenance and safety of electronic and electro-medical equipment. Based at Worthing Hospital with good workshop and office facilities, the job will involve travel throughout the district.

Commencing salary £2,931 - £3,834 pa, plus £291 and Stage II supplement.

Job description and application forms are obtainable from the District Personnel Officer, 129 Brighton Road, Worthing, Sussex BN11 2ET.

Closing date for completed applications: October 31, 1977.

West Sussex Area Health Authority
WORTHING DISTRICT

Assistant Engineer

(Male or Female)

Salary: £3,063 - £3,507 pa, plus £291 pa supplement and Stage II award.

The appointed person will be required initially to assist with the commissioning of engineering services for the Phase V Development at Southlands Hospital and preparing a fully documented planned preventive maintenance scheme for this building.

Applicants must have served an apprenticeship in mechanical or electrical engineering and have an Ordinary National Certificate in Engineering.

Application form and job description available from District Personnel Officer, 129 Brighton Road, Worthing, Sussex BN11 2ET. Tel. Worthing 205111 Ext. 629.

Closing date for completed applications: October 31, 1977.

ESSEX AREA HEALTH AUTHORITY
Harlow District

Hospital Engineer

(24½ points or more)

required at St Margaret's Hospital, Epping. Sound knowledge of mechanical, electrical and laundry equipment found in a general hospital together with management ability and knowledge of modern techniques. Qualifications as per NHS conditions of service (HNC or equivalent).

Salary scale: £3,615-£4,140 pa, plus Stage I Supplement £291, London Weighting £141, and Stage II Supplement 5% of gross earnings. Married accommodation available.

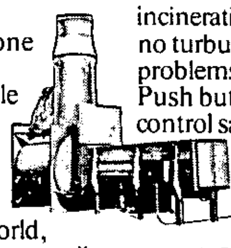
Application form/job description available from District Works Officer, Level 16, Terminus House, Harlow, Essex. Telephone: Harlow 417221, ext. 53.

Closing date: October 30, 1977.

'Consumat – the sweet smell of success in waste disposal.'

Miss N. Ostril

The clean, clinical destruction of hospital waste calls for much more than a fire and a chimney. The smoke and residue alone present a serious potential health hazard – unacceptable under the terms of current anti-pollution legislation.



That's why over 3,000 Consumat incinerators are installed throughout the world, reducing all types of waste to a sterile ash – simply, safely and automatically.

The Consumat "starved-air" incineration system has no grate, no turbulence, no smoke, and no problems.

Push button operation and easy control saves operator time and cuts running costs.

It's the finest and most reliable incineration system in the world.

Ask for full details.

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and 64201 (STD Code 0709)
Grams: Jenkins Rotherham Telex: 54111