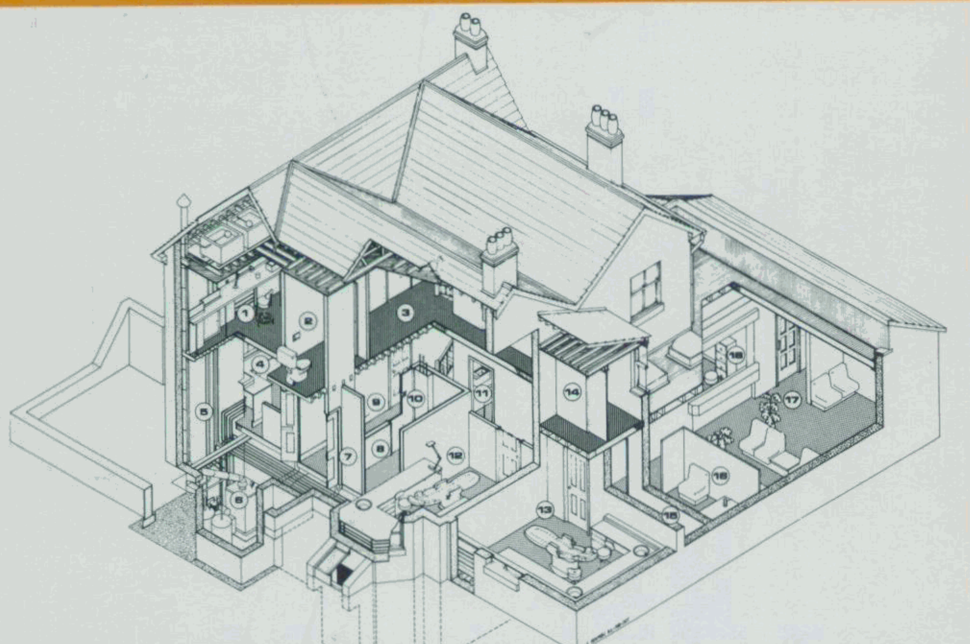
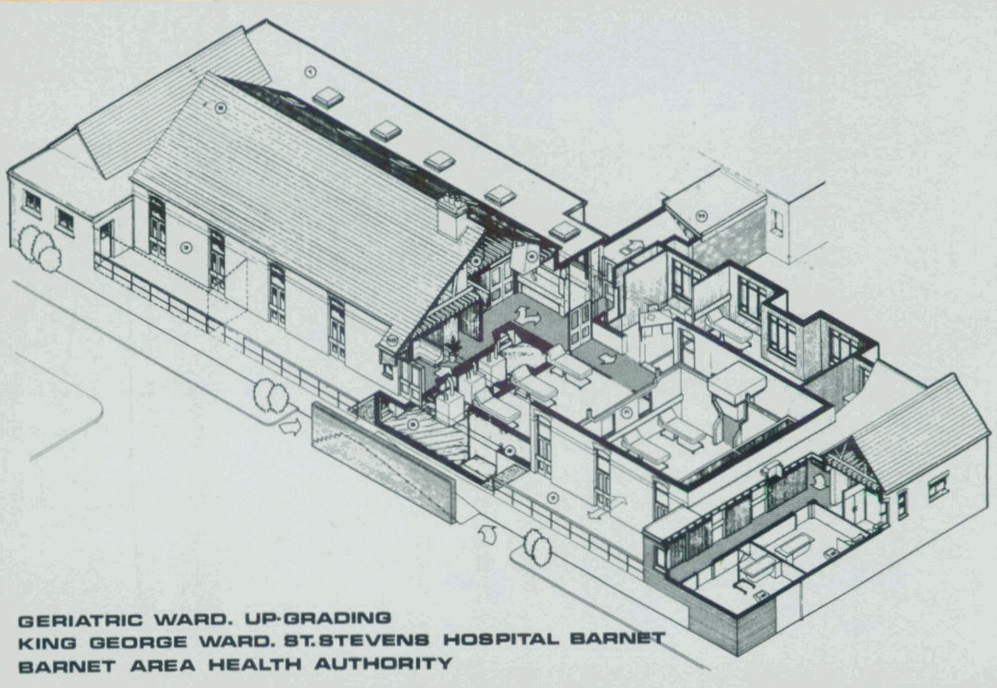
HOSPITAL ENGINEERING

August 1978

The Journal of the Institute of Hospital Engineering



DENTAL GROUP PRACTICE: DORKING



GERIATRIC WARD. UP-GRADING
KING GEORGE WARD. ST. STEVENS HOSPITAL BARNET
BARNET AREA HEALTH AUTHORITY

Upgrading existing buildings in the NHS Estate

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HOSPITAL ENGINEERING

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The Journal of the Institute of Hospital Engineering

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Geriatric Ward Upgrading, St. Stephen's Hospital, Barnet, and Dental Group Practice, Dorking (see page 6)
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Institute News

Hospital Engineering Bursary Award
The First Winner

The successful candidate in the first year of the Bursary Competition is Mr R. D. Buckley, District Works Officer to the Roehampton Health District.

The Award of £450 goes to Mr Buckley, who will use it to research and investigate the environmental conditions for the treatment of patients suffering from burns. He will visit special 'Burns Units' in Texas, Ohio and Massachusetts as well as in England and Northern Ireland.

In due course, the Institute will hope to publish the result of Mr Buckley's investigations.

One-day Symposium Success

The One-day Symposium on 'Recent Development in Hospital Sterilising Processes' held at Imperial College, London on June 14 produced a 'full house'.

The response for tickets was such that the maximum number was reached two to three weeks before the day and over fifty applications for tickets had to be refused.

The papers given at this Symposium will all appear in *Hospital Engineering* as soon as possible.

The next One-day Symposium will be held at The Institution of Mechanical Engineers, Westminster, on November 1, and will deal with the application of the Health and Safety legislation.

The usual leaflets setting out the day's programme and incorporating a ticket application form will be distributed to members, wrapped in the September Journal.

In view of the great support these Symposia attract and particularly the recent experience of the 'House-full Notices', early application for tickets is advised!

Five-Branch Meeting 1978

The 1978 Five-Branch Meeting was organised by the Midlands Branch on Saturday, May 20 in the Witts Lecture Theatre, The Radcliffe Infirmary, Oxford. The President of the Institute, J. Richard Harrison, chaired the meeting and introduced two separate papers. A total of 55 members and guests from the East Anglian, London, Midlands, Southern and South-Western branches attended this very interesting meeting.

The morning paper was presented by A. C. Selman, Principal Engineer DHSS, and was entitled *The Maintenance of Medical Equipment.* In this paper Mr Selman illustrated the extent to which the engineering content of health care had increased over the years, and he also suggested the scale of provision considered necessary for the maintenance of this equipment.

The afternoon paper entitled *The Engineering Aspects of Renal Dialysis and Transplantation* was presented by three speakers:
Professor P. J. Morris PhD FRCS,
Dr D. O. Oliver, Consultant Physician, and
Dr J. D. Melbourne BE(Chem) PhD.

Professor Morris is the Nuffield Professor of Surgery at Oxford and heads the surgical team. He has a particular interest in Renal Transplantation and is also head of a very large and active research group.

Dr Oliver is the Director of the Renal Dialysis Unit at the Churchill Hospital in Oxford and works very closely indeed with Professor Morris.

Dr Melbourne is Managing Director of Melcon Water International Ltd, who are an independent specialist company involved in water treatment including de-salination, sewage and effluent treatment. He has been involved in a detailed investigation into water treatment plant for Renal Dialysis use, with Dr Oliver.

In this paper the medical principles behind Renal Dialysis were described by Dr Oliver, and Dr Melbourne described the many engineering problems that had to be solved to provide the necessary water treatment.

Professor Morris spoke briefly on his work in the Transplantation field.

East Anglian Branch
Branch Officers for 1978

Chairman
Mr R. G. Kidsley, District Works Officer, Bury St Edmunds Health District.

Vice-Chairman
Mr F. D. Blackburn, District Works Officer, Norwich Health District.

Hon Secretary and Treasurer
Mr M. Brooke, District Works Officer, Great Yarmouth and Waveney Health District.

Committee Members
Mr R. G. Freestone, District Engineer, Cambridge Health District.
Mr C. P. Le Breton, Assistant Engineer, Norwich Health District.
Mr J. A. Parker, Area Works Officer, Norfolk Area Health Authority.
Mr G. G. S. Turnbull, Sector Engineer, Norwich Health District.
Mr K. Allison, Hospital Engineer, Cambridge Health District.

London Branch
Target Programme for Meetings

Date	Subject	Arranger(s)
September 26, 1978	Mechanical Ventilation of the Patient, and the Pathological and Electrical Hazards	Dr B. G. B. Lucas
November 21, 1978	The Maintenance Manager of the Future	R. J. Ashton
January 23, 1979	Craft and Student Apprentices in Health Care Engineering — Do They Have a Future in the 80's?	R. D. Buckley
March 27, 1979	Annual General Meeting, and The Institute and its Influence	

Please contact Meeting Arrangers with ideas, or offers of help at meetings.

Usually, meetings are held at the Wolfson Theatre, National Hospital, Queen Square, WC1, unless notified to the contrary. Any enquiries to D. L. Davies, Branch Chairman. Telephone: Office 01-717 6431; Home 0277 213995.

Midlands Branch

Among plans for future branch activities, it is hoped that a colliery visit might be arranged in September 1978, and that Mr Wagstaff of DHSS will agree to present his paper on noise to an evening meeting in November 1978.

The following subjects are possibles for 1979:
Electronic and Medical Equipment — from the circuit theory point of view;
Electrical Safety, by a Chief Inspector of the Health and Safety Executive;
The Medicines Act.

Mr R. G. Taylor advises that a Cheese and Wine party is to be held on Tuesday, October 3, 1979, at Highcroft Hospital — approximate cost £2.50 per ticket.

Next Meeting
Wednesday, September 6, 1978 in the Recreation Hall, St Cross Hospital, Barby Road, Rugby, commencing at 18.30 hours.

Committee
The Committee are:
Chairman: D. L. HALL
Vice-Chairman: R. J. SEAR
Hon. Secretary/Treasurer: C. SMITH
Papers Officer: R. J. SEAR.

Welsh Branch

The Committee Members for 1977/78 are:
Chairman: Mr T. ROCHE
Vice-Chairman: Mr P. JACKSON
Secretary: Mr D. GRIFFITHS
Treasurer: Mr B. V. WILLIAMS

West of Scotland Branch

The Branch Officers and Committee Members for the 1978-79 session will be:
Chairman: W. JACK
Vice-Chairman/Minute Secretary: A. PETERS
Hon. Secretary: T. M. SINCLAIR
Hon. Treasurer: D. E. MOSS
Committee Members: D. BRADLEY
I. CADENHEAD
W. GORMLEY
A. GRAY
B. D. EDGAR
A. McDOUGALL
J. G. VERNON

Mid Scotland Branch

11th Weekend Conference October 19-21 — Dundee

The Weekend Conference this year will be held in Dundee. The Tayside Health Board along with the Faculty of Medicine, University of Dundee, are providing facilities for the Conference at the new Ninewells Teaching Hospital and Medical School.

Mr. J. Knox, Chairman of the Tayside Health Board, will open the Conference and Mr J. R. Harrison CBE CEng(Fellow), President of the Institute of Hospital Engineering, will be attending. All Sessions will be open to visitors at no charge. Visitors may attend independently or as guests of members. Morning coffee, lunch and afternoon tea will be available at the Hospital during the Conference.

Members are reminded that they may be granted Conference leave and expenses by their Health Board.

The programme includes papers on: *The Engineer, The Pharmacist and The Medicine Inspectorate* by J. D. Appleton Esq FPS, Chief Administrative Pharmaceutical Officer, Tayside Health Board, S. B. Fairchild Esq MPS, Medicine Inspectorate, DHSS, and R. Cowtan Esq, CSA Scientific and Technical Branch: *The Evolution of Hospitals and Some Current Concepts* by J. Bolton, Chief Works Officer, DHSS; *Computers as an Aid to Maintenance* by J. Wilkie Esq BSc(Hons) ARICS MIB, Area Maintenance Manager, Borders Health Board; visit to the Dundee Limb Fitting Centre, 133 Queen Street, Broughty Ferry, and a Lecture on *Rehabilitation Engineering* by B. Meadows Esq BSc, and other members of the Bio-Engineering Team; *Management and Industrial Relations in the National Health Service* by I. C. Massie Esq MA(Oxon), Senior Lecturer in Employee Relations, Faculty of Management and Social Studies, Dundee College of Technology.

Details and Registration
In order to finalise arrangements for the Conference please register promptly, preferably not later than September 30.

Further details and registration forms from: Mr T. S. Grant, 21 Walnut Grove, Dunfermline, Fife. Telephone: Dunfermline 24421.

Amos Millington – North West Council Member

Amos Millington was elected to be Council Member of the Institute, representing the North West at the recent AGM. He was born in Walkden, Manchester, in 1940. After completing his education at Worsley Technical College, he joined De Havilland Propellers Co Ltd (later Hawker Siddely Dynamics Ltd), for a five-year apprenticeship. Thereafter he remained with the company as a planning engineer until November 1965, when he joined the Health Service as Deputy Group Engineer with Salford HMC.

He became a member of the Institute in 1967, and writes that "on attending my first branch meeting a 'merry band of elders' persuaded me to join the branch committee to 'lower the average age of committee members'. Flattered and 'innocent' I agreed, and became a member of the branch committee and have enjoyed its membership ever since. In 1970 and 1971, I served as Branch Chairman".

Mr Millington was appointed to the post of Area Engineer with the Salford AHA (Teaching) in 1975.

He lives in Worsley, Manchester and is married with a daughter and a son.

Lionel Northcroft – an appreciation

Lionel Northcroft Esq OBE BSc CEng FIMechE FIHVE PP IHospE PP IPlantE, engineer and industrialist, died on Saturday, July 15, at 2.30 pm, after suffering ill health for some time. He will be counted as a great man and will be sadly missed by his many friends in the National Health Service.

Born on August 30, 1900, he was educated at Rossall School and graduated as a BSc(Eng) with London University. He served an engineering apprenticeship with Sir W. G. Armstrong and Co. was with Vickers for several years, and followed this by service with ICI Ltd, at Billingham. He then created his own Company, Spirax Sarco, and as a result of hard work and determination he became a leading industrialist of this country.

During the last war he did a great deal of work for the then Ministry of Fuel and Power, and served as a member of the Steam Utilisation Panel, the Steam Research Panel, and the South Western Regional Fuel Efficiency Committee. He was one of a small band of helpers presented with inscribed leather-bound copies of the 'Efficient Use of Steam' by Sir Oliver Lyle.

He was, for many years, closely associated with the Federation of British Industries, being a member of the Grand Council, Vice-Chairman of the South Western Regional Council, a member of the Fuel and Energy Committee and a member of the Fuel and Power Consumers' Policy Committee. He was also associated with BSIR, as a member of the Heat Transfer Committee of the Mechanical Engineering Research Board at East Kilbride.

He was elected President of the Institution of Plant Engineers in 1948 and was the second man to hold that office; and he was chairman of various Institution committees, including education. He was President of the Institute of Hospital Engineering during its very formative period, between 1967 and 1969; and it is largely for his work during that period and later, that we in the health field best remember him. His work received recognition by his appointment as an Officer of the Most Excellent Order of the British Empire.

He always had an interest in higher education and technical education and for some time was associated with the City and Guilds of London Institute. It was a happy day for the Health Service, and in particular Health Service Engineers, when his interests spread to the hospital world. He did much to guide and steer the Council of the Institute of Hospital Engineering during the formative period of incorporation and helped to promote the 'Keele' courses in their formative years. He was also closely associated with the consultations which the Institute had with the King Edward's Hospital Fund for London, which resulted in an invitation to the Institute to set up an Engineering Advisory Panel. He promoted the efficient use of instrument sterilisers and autoclaves, and was actively engaged on work in association with Dr Bowie and Professor Howie on the improvement of sterilising efficiency. He also co-operated in the development of engineering techniques applied to the aseptic treatment of wounds.

Through his generosity, a fund was set up to permit the Award by the Institute of a Silver Medal annually to the author of the technical paper considered by adjudicators to have contributed most to the advancement of hospital engineering. This is known as the 'Northcroft Silver Medal Award'. His avowed purpose was to encourage the writing of technical papers which would benefit, not only the reader, but the author himself through the discipline and research demanded of authorship.

He was the author of *Steam Trapping and Air Venting*, a book widely used throughout the world, and was the author of many other publications dealing with process steam engineering. Through his business he did much, by way of lectures, correspondence courses and training sessions, to help hospital engineering staff throughout the world to use steam, and steam-using plant more efficiently.

As a mark of the esteem in which he was held, it was decided to name a new Lecture Hall at Falfield in his honour, and on June 21, 1977, in the presence of five past Presidents of the Institute, Lionel Northcroft formally opened the Northcroft Hall. It will serve as a permanent memorial to him.

He leaves a widow, two sons, three daughters and 15 grandchildren.

Lionel Northcroft will be remembered by engineers in the Health Service, and by those visiting Falfield, by Wren's epitaph:

"Si monumentum requiris,
circumspice".
(If you seek his monument, look
around you).

JOHN BOLTON

This is the final paper given at the Institute's one-day symposium 'Making the Best Use of the NHS Estate' on March 1, 1978. The authors are partners in Design Team Partnership of Kettering, Northamptonshire.

Practical Examples and Data for Upgrading Buildings in The Health Estate

A. M. RODGERS MSIA FRSA D. S. DREDGE RIBA DipTPI

Until recent years the DHSS, the DES and the UGC have been almost totally committed to and engaged in a new building euphoria. Examples of this euphoria can be seen by the growth of the new Universities in the late Fifties and Sixties; the Polytechnics in the late Sixties and early Seventies, and the new Hospital Building Stock which appeared during the same period. At that time both partners were working on the University Building Programme. Also at that time money, resources and manpower were nearly always readily available, and consultants and administrators alike were immersed in creating what, at that time, were new standards and ideals. In certain design areas it also became a period for experiment. In retrospect it is likely that in some cases unacceptably low standards were created and the ideals we thought of have now become obsolete. Nevertheless, for people involved in the construction industry it was a particularly hectic and exciting time. For many young architects it was instant Utopia.

It is not surprising that during that period of plenty (the Fifties and Sixties) very little time or thought was given to the rehabilitation and renovation of existing buildings. Indeed, it was openly said that in many areas the existing building stock would be demolished and rebuilt, and therefore there was no reason to conserve or enhance existing buildings. It was towards the end of this boom period that Central Government and Local Government became concerned with the loss of so many buildings of architectural and historical value. The Civic Amenities Act 1967[1] in fact, did much to encourage and create interest in the preservation and use of older buildings.

It was gradually realised in certain areas that buildings and their facilities would not always be so readily available. Accordingly, in the late Sixties, useful research work on space utilisation within existing buildings was being carried out by Professor Musgrove at University College,[2] and a particularly useful philosophy related to the conversion and adaptability of Science Laboratories was being developed by the Laboratories Investigation Unit.[3] This work relates specifically to the field of Education, but many of the techniques and concepts can be usefully employed in the Health Field.

We were particularly fortunate in being involved with the LIU in a pilot project in the early Seventies[4] adapting an old bakery building into a Science Laboratory. From this background one can see that the rehabilitation of existing hospital buildings has been a much neglected subject.

Current Crises

Lack of resources and severe cut-backs in capital expenditure have forced us to reconsider our needs, our building stock and our existing facilities. We have been pressurised into re-appraising what we possess in terms of building stock and facilities, and how to exploit these to greater effect and usage. In effect, it is taking a new look at old buildings and in many respects we are perhaps fortunate in being forced to do so, because it will give us the impetus and time to look at the problem of the Health Estate and its facilities to see if there is a more economical solution.

It is now recognised, for example, that not all hospital accommodation needs highly sophisticated Hospital Buildings. This has been recognised in the educational area, where studies have been made on the management and planning for change in laboratories.[5]

We are now starting a movement to upgrade buildings on what eventually could be a large scale. So far, it appears that upgrading schemes are being completed without information or guidance for the planning team. Despite this lack of guidance, part of our Practice has played an active part in the upgrading of buildings over the past few years, both in the private and public sectors.

Based on the results of this completed work and the practical experience of our Practice, we have made statements and have developed procedures which we think are particularly relevant to small to medium sized projects (eg those carried out at District or Area Level).

Site Location and Layout

Once the basic needs of the community or the client have been agreed the location of site should be established in relation to the community being served and other community and social services facilities.

It is necessary to establish what, if any, survey material exists, check and up-date it if necessary, or start anew. One should acquaint oneself with and record key facilities and relationships of support services (eg present and future location of stores, CSSA, Laundry), and the relationship of buildings to the site and each other. The physical conditions of the site and levels, must be checked, and the engineering services including main drains should be positioned accordingly. The site must be analysed for present and future traffic flow, communications, established grounds and planting etc.

Survey Existing Buildings

Age, condition and structural type of the building must be ascertained and the dimensional and structural surveys carried out. NB: Not only should the plan be surveyed, but sections and elevations must be made to appreciate the volume of spaces. Details of primary and secondary elements also should be checked, eg windows, skirtings, joinery etc. This will not only help develop an understanding of the building but will help to catalogue the extent of maintenance work etc. The character of the building and its environmental aspects should be understood and one must ensure that the existing services are located, inspected and tested. A level survey is needed if extensions are contemplated.

Exploitation of Existing Building and Site

The proposed use of the building or site is nearly always determined at the stage when we, as consultants, are commissioned. Usually the pressures for utilisation of existing space are so great that the choice of building and use is minimised, so that one has to assess the potential of the space. An example of retaining the same space usage is the King George Ward, while new or changed use can be seen at the Pathology Laboratory, Colindale. Improved space utilisation or time tabling is demonstrated at the Biology Laboratory at Leicester, while an extension to accommodate extra use can be seen at West Hendon.

Design Stage

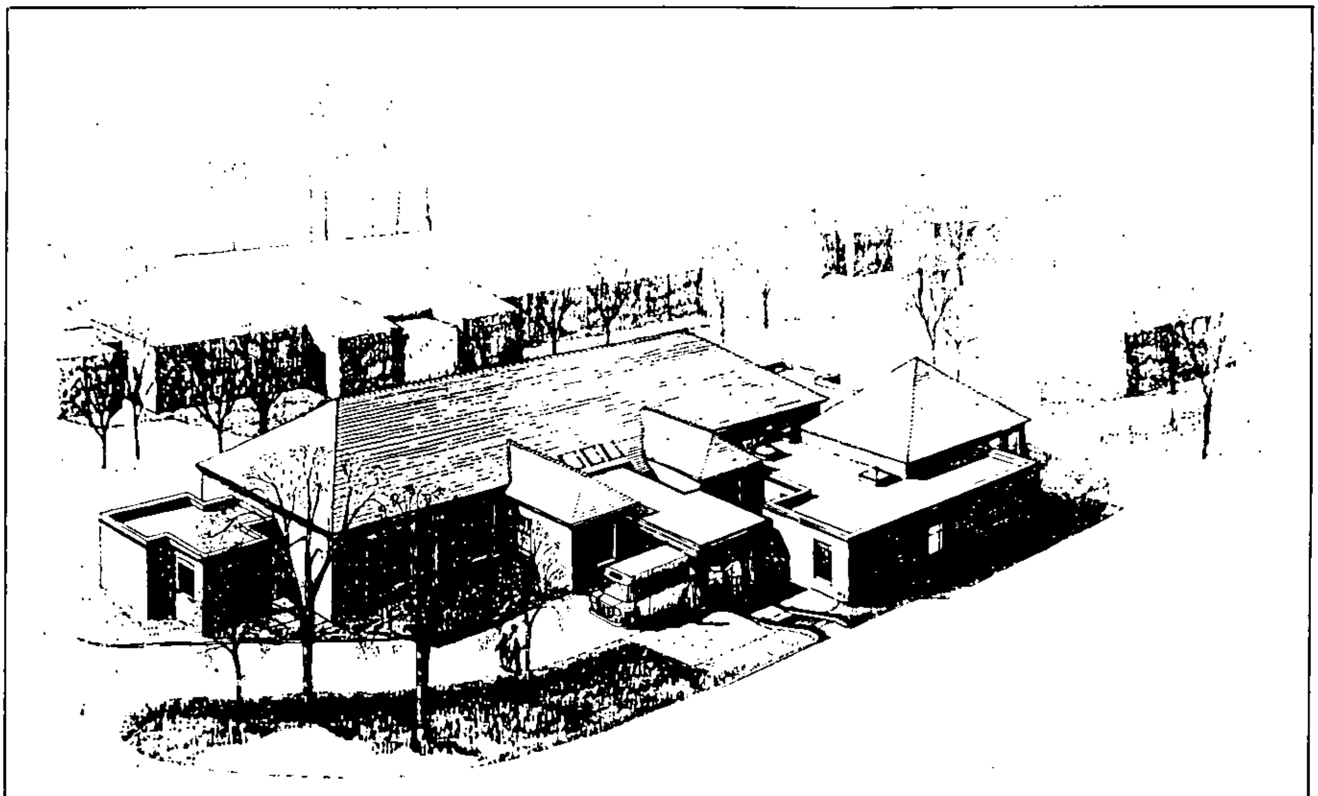
We do not intend to discuss this stage in detail, except to say that it obviously differs from designing a new building. It would, however, be proper to mention the important factor of specified and accepted standards — that is, environmental standards (lighting, ventilation, heating etc), room areas and volumes, relationship of spaces, and general positioning of circulation spaces and areas. Of course, these already exist and will determine certain factors in a new scheme. It may well be the case, therefore, that accepted standards (available usually only for new buildings) will have to be challenged. In our experience the floor area allowance for assisted bathrooms is in excess of that actually required. This is illustrated in new buildings by the amount of spare space that gets filled up with stored wheel chairs, etc.

Another example is that of Dental Surgeries where the floor area is largely determined by the ergonomics of a dentist's work area (length of arms and reach for retrieval of instrumentation)[6] and we would normally allow one-third less area than the accepted standard. We mention this because the designer very often has to have the experience and ability to create a new workable standard within the constraints of what is already in existence.

Personal Involvement, Morale and Time Scale

Here are some general points of upgrading, relative to the Brief and inspection of a scheme from a client's point of view. Upgrading, from a client's point of view, is almost instant and the exercise is controlled at a local level, compared with a new build-

West Hendon Geriatric Day Hospital, Barnet AHA.



ing when the long arm of bureaucracy tends to take over and the time span is usually of great length. For schemes up to £50,000, eg those carried out by the Area and District, the decision-making is personalised, and a real sense of involvement by the project team and the users is usually evident. Usually the time scale from the complete briefing process to the finished building is shorter than for a new building. The interest and complete involvement of the project team is, therefore, not difficult to achieve and hold.

In addition, communication of ideas is somewhat easier from the client's and architect's view-point. For one thing, the building already exists, and its current and future use can be described both physically and on drawings. From the point of view of a client's satisfaction, the finished result will at least be considerably better environmentally than that which exists in the original building. In our experience, upgrading can give tremendous satisfaction within a short space of time, and can improve morale at area and district level very quickly.

Interior Decoration

Not all existing buildings are buildings of architectural and historical interest, although we do understand that in the West Midlands RHA alone there are 35 listed Health Buildings. There is no doubt that with buildings of such calibre, great care has to be taken to ensure that the interior decoration enhances the existing internal character and quality. Indeed, at this level of work the interior aspects are very often synonymous with the exterior.

With the majority of up-grading schemes we have found that the interior becomes a 'cut and carve' exercise where architect's pedantic details are not called for. However, what is usually called for is co-ordinated colour schemes which enhance the complete interior spaces. The type of colours should be selected to suit the purpose or use of the building. In developing a scheme it should also be noted that odd items of furniture and/or equipment (eg a model telephone in waiting area at Rosa Morison) will always creep in and may not be suitable in colour.

Recommendations

In upgrading existing health buildings, certain factors should be recognised. Some of these can be advantageous to

Actual Examples of Upgrading, Showing Costs and Time Scale

Therapy Unit, Adjacent King George Ward, St. Stephens Hospital, Barnet

Gross Area of Extension	125 sq metres
Commission Date of Project	September 1977
Start Date on Site	January 1978
Anticipated Completion on Site	June 1978
Cost of Building including specialist services and fittings	£34,258
Cost of External Works	£3,000
Total Contract Value	£37,258

Linen Store, Edgware General Hospital

Gross Area of Existing Building Upgraded	80 sq metres
Gross Area of Extension	120 sq metres
Commission Date of Project	October 1977
Start Date on Site	January 1978
Anticipated Completion on Site	August 1978
Total Contract Value including specialist services and fittings	£46,260

Conversion of Kitchen/Dining Area, Edgware General Hospital

Gross Area of Existing Building Upgraded	269 sq metres
Commission Date of Project	October 1977
Start Date on Site	January 1978
Anticipated Completion on Site	August 1978
Total Contract Value including specialist services and fittings	£47,500

Dental Laboratory, Hendon Central Clinic

Gross Area of Existing Building	133 sq metres
Commission Date of Project	September 1977
Start Date on Site	January 1978
Anticipated Completion on Site	May 1978
Total Contract Value including specialist services and fittings	£36,894

Pathology Laboratory, Colindale Hospital

Gross Area of Existing Building Upgraded	70 sq metres
Commission Date of Project	November 1977
Start Date on Site	January 1978
Anticipated Completion on Site	March 1978
Total Contract Value including specialist services and fittings	£11,281

Private Clinic, Harley Street, London

Gross Area of Existing Building Upgraded	1,750 sq metres
Commission Date of Project	January 1974
Contract Period to be agreed	
Total Contract Value including specialist services and fittings	£500,000

Nurses' Accommodation, Booth Road, Colindale (2 Phases)

Gross Area of Existing Buildings Upgraded	593 sq metres
Commission Date of Project	February 1976
Start Dates on Sites	November 1976 January 1977
Completion on Sites	March 1977
Cost of Building including fittings	£30,000
Cost of External Works	£10,000
Total Contract Value	£40,000

Geriatric Day Centre, Queensbury Ward, West Hendon Hospital

Gross Area of Existing Building Upgraded	289 sq metres
Gross Area of Extension	145 sq metres
Commission Date of Project	December 1975
Start Date on Site	January 1976
Completion on Site	May 1976
Cost of Building including specialist services and fittings	£49,000
Cost of External Works	£3,000
Total Contract Value	£52,000

Mentally Handicapped Day Centre, Rosa Morison House

Gross Area of Existing Building Upgraded	685 sq metres
Commission Date of Project	July 1976
Start Date on Site	September 1976
Completion on Site	May 1977
Cost of Building including specialist services and fittings	£59,000
Cost of External Works	£15,000
Total Contract Value	£74,000

Medical Group Practice, Luton

Gross Area of Existing Building Upgraded	322 sq metres
Gross Area of Extension	133 sq metres
Commission Date of Project	November 1975
Start Date on Site	September 1976
Completion on Site	June 1977
Cost of Building including specialist services and fittings	£45,500
Cost of External Works including garage	£9,500
Total Contract Value	£55,000

Dental Group Practice, Dorking

Gross Area of Existing Building Upgraded	276 sq metres
Gross Area of Extension	55 sq metres
Commission Date of Project	October 1975
Start Date on Site	May 1976
Completion on Site	September 1976
Cost of Building including specialist services and fittings	£42,500
Cost of External Works	£3,500
Total Contract Value	£46,000

Springfield Ward, West Hendon Hospital

Gross Area of Existing Building Upgraded	1,520 sq metres
Commission Date of Project	January 1978
Anticipated Start Date on Site	February 1978
Anticipated Completion on Site	April 1978
Cost of Building including specialist services and fittings	£23,000
Cost of External Works	£10,000
Total Contract Value	£33,000

King George Ward, St. Stephens Hospital, Barnet

Gross Area of Existing Building Upgraded	431 sq metres
Commission Date of Project	September 1977
Start Date on Site	January 1978
Anticipated Completion on Site	June 1978
Cost of Building including specialist services and fittings	£68,000
Cost of External Works	£2,000
Total Contract Value	£70,161

the upgrading of the Health Estate and others not. The points that come readily to mind are, in an *ad hoc* order:

— Pre-war hospitals (eg fever hospitals) were very often built for isolation and not integration.

— In cost terms, higher sums need to be allowed for contingencies (unknowns) on upgrading schemes.

— A particular complex of hospital buildings built in the traditional manner might present problems for extensions if an industrialised system were to be used.

— It might be necessary to accept patient occupation of the building while building works are in progress.

— Upgrading schemes are complete for all stages of the planning and design process and can be referred to during these procedures.

— Re-use of existing services ie drainage, heating, lighting.

— Use of existing planting/landscaping.

— The finished scheme will have carried out a high proportion of scheduled maintenance work.

— Quality of space and room size of certain types of existing buildings is not possible to provide under present cost figures for new building.

— Relative costs per square metre less than present day building costs.

— Patients can very often relate more easily to the domestic scale and character of an existing building than to a new institutionalised one.

— Certain activities are not so specialised as planners make them out to be.

— The morale of the staff who are at the sharp end of the Health Service can be given a boost by example of immediate action.

If it is accepted as a part of DHSS policy that the Health Estate be upgraded, we would make the following recommendations:

A Development Control incorporating a complete survey of the Health Estate must take place.

Guidance must be given and a system developed to ensure that Planning teams implement the exploitation of the existing building stock to an acceptable standard.

Simple and practical guidelines or a manual should be made available immediately to help officers in making the necessary nuts and bolts decisions on matters of upgrading. This especially applies to standards and techniques of upgrading where many officers and architects still think in terms of new buildings — the suspended ceiling brigade.

Categories of non-specialised uses should be established (eg day centres and combined social and health services provisions) and liaison formed with County and District Planning Departments to establish the availability of existing properties with a view to a change of use. ie There has been a tremendous amount of sizable property available on the market, suitable for upgrading for non-specialised health use, and which would be likely to receive a favourable response for a change of use by a Planning Authority. Likewise, to our knowledge, no-one yet has capitalised on the office developments which are unoccupied.

References

[1]Civic Amenities Act HMSO London 1967.

[2]Professor Musgrove, Head of Architecture, University College, London. Work and Research relative to Space Utilisation.

[3, 4]Laboratories Investigation Unit. Paper No 6 August 1972 'Adaptable Furniture and Services for Education and Science' and Paper No 7 September 1974 'Adaptable Laboratories: Practical Observations on Design and Installation'.

[5]Dewhurst F. and Rodgers A. M. 'Adaptable Laboratories: Management and Planning for Change'. Laboratories Investigation Unit. To be published.

[6]Osbourn J. and Rodgers A. M. 'Planning for General Dental Practice'. From an exhibition held at the King's Fund Centre, London. June/July 1973.

Waste Gas Disposal an alternative view

D. W. BETHUNE MA MB BS FFARCS

In *Hospital Engineering* for October 1977, an article entitled 'Waste Anæsthetic Gas Systems', proposed the installation of separate independent active systems for the removal of waste anæsthetic gases. To me this appears to be unnecessary in the context of the modern UK operating theatre.

In Hospital Building Note 26 (1967) there are two significant recommendations. The first is that theatre ventilation plant should be designed to be non-recirculating, and the second is that a mechanical extract point should be provided in each anæsthetic room.

Our anæsthetic gas disposal system was designed to use this mechanical ventilation extract point provided in the anæsthetic room. This has proved very satisfactory over a period of five years — not surprising, when the performance of the anæsthetic room mechanical ventilation extract point is considered. A moderate sized anæsthetic room will have an internal volume of about 1,500 cubic feet. Even with only ten air changes per hour the extraction rate through the duct will be in excess of 7,000 litres per minute (250 cubic feet). On measuring the pressure in the mechanical extract ducts leading from the anæsthetic room inlets in theatres in our district, we have found pressures varying from 0.05 to 2 mm of water. These pressures are remarkably constant, and even if the anæsthetic room grille is completely obstructed they do not exceed 3 mm H_2O.

A simple diagram (*Figure 1*) emphasises the advantages of using the ducting leading from the anæsthetic room grille for the disposal of anæsthetic gases. The duct can be considered as a collecting chamber open to atmosphere at one point, and with an air-flow to evacuate it of at least 7,000 litres per minute. Under these circumstances multiple inlets can be connected to the duct as with any theatre/anæsthetic room combination the total flow of pollutant gases will not exceed 30 C/min, giving a dilution in the duct greater than 200 : 1.

It is interesting that this anæsthetic room duct is specified in the hospital building note 'because of the presence of gases', so its design must have taken account of the fact that anæsthetic gases, with their possible corrosive action, would be present in the air in the duct. However, even if the patient's expired air contains 5% volatile agent the level in the duct will only be 0.025%. This is unlikely to have a deleterious effect on the air moving equipment. As a council of perfection an inclined plane manometer should be fitted to monitor the gradient between the anæsthetic room and the duct, but in our experience the pressures and flows through the ducts are remarkably constant.

The possibility of occlusion of the flexible connecting tubes, which will be used to connect the patient to the ducting, must be borne in mind, and a suitable pressure relief block has been described (by Bethune, Collis and Latimer — Anæsthesia 1976, Vol 31, Page 1254), which also incorporates a flexible reservoir to give visual indication that the whole system is functioning effectively. It is hoped that future editions of the Hospital Building Note will recognise the possibility of gases being released in the operating theatre and suggest that suitable mechanical extract points are provided in that area as well as in the anæsthetic room.

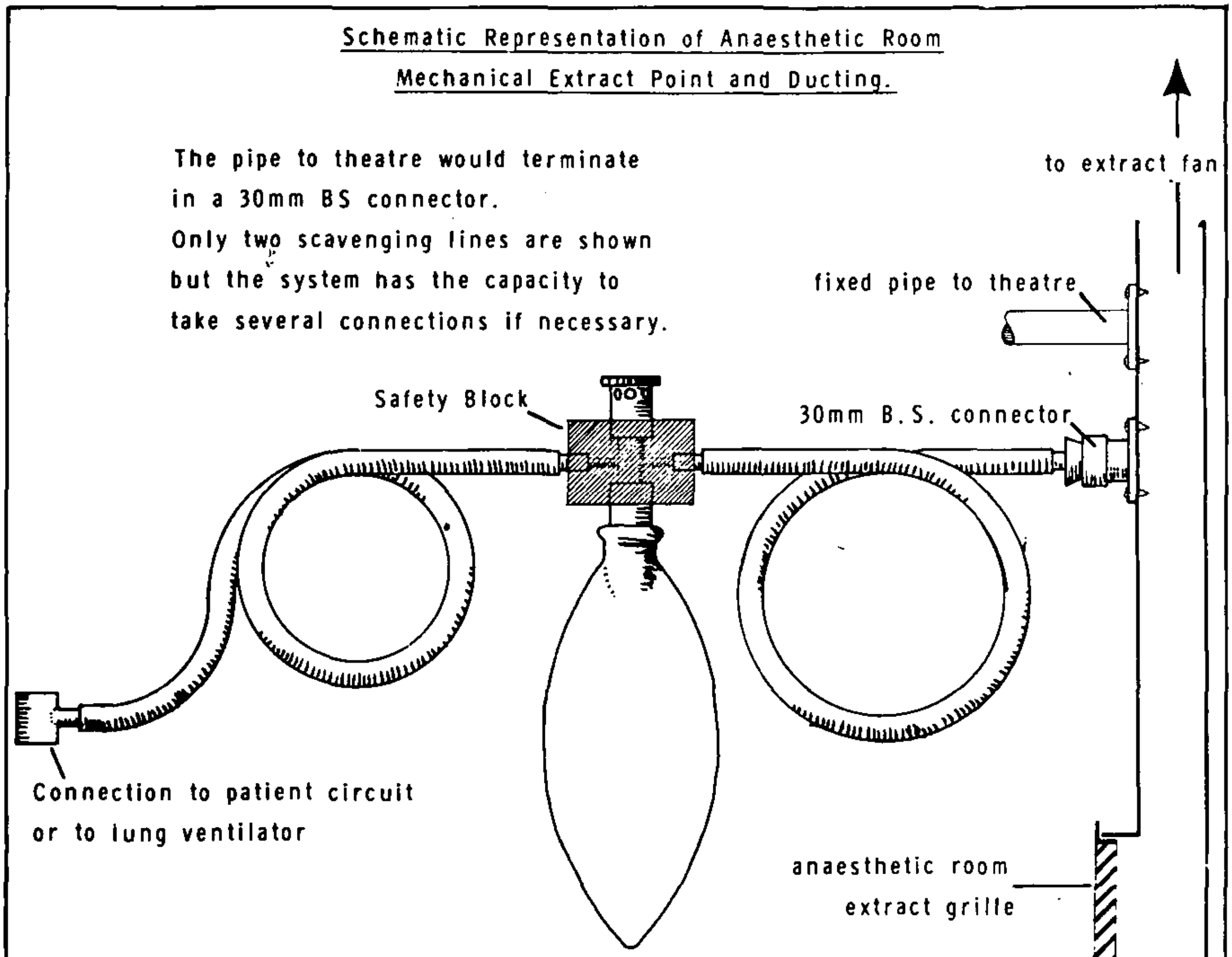
With regard to ventilators and other items of equipment, which generate exhaust flows and volumes out of all proportion to the patient's expired flows and volumes, it can only be suggested that this problem must be the responsibility of the manufacturers of such devices. They should provide the means to move the gas from patients and their device to the fixed extract point, and that this special connecting apparatus should be considered part of their device.

While no definitive standard exists, there is an understandable reluctance to invest money and time in systems which may be superseded by future developments. However, the capacity of any system using the theatre ventilation to dispose of anæsthetic gases is extremely generous and it is inconceivable that a flow requirement in excess of 7,000 l/min would ever be specified.

In the same way it is most unlikely that any limit on negative pressures would not allow a depression of 5 mm H_2O at the extract point. The arguments which have been advanced against using a theatre extract point are numerous, and in the main, spurious. It has been suggested that it is not possible to guarantee the flow in any particular part of an air conditioning system. This seems very strange as such systems must have a calculated and known performance. In addition, after any modification or adjustment to the ventilation plant, the functioning of the theatre ventilation will obviously have to be checked before the operating theatre can be used clinically. Additional simple monitoring with a fixed incline plane manometer will confirm the correct function of the ventilation system.

It has been suggested that the waste anæsthetic gases in the theatre ventilation ducts may damage the moving parts of the system. This is unlikely — the dilution is in the ratio of about 200 : 1 — also the majority of the waste gases from anæsthetic systems have been extracted through the theatre ventilation for many years. Obviously this simple type of disposal cannot be used *with a recirculating* system. Here more careful design will be needed to site the termination of the scavenging ducts in that part of the air flow which is not recirculated. This is unlikely to present much problem in the U.K. as non-recirculating systems have always been recommended.

In conclusion, the theatre extract system can be used to provide efficient, safe and inexpensive active disposal of anæsthetic gases. It is difficult to see a valid case for the additional capital and maintenance cost of separate anæsthetic gas disposal systems in operating theatres, which are already provided with efficient non-recirculating ventilation systems.



Schematic layout of anæsthetic room mechanical ventilation extract duct and connections for anæsthetic scavenging systems. Only two connections are shown, but the system has the capacity to take many more.

Superheat in Porous Load Autoclaves and its effects on the indicator stripes on paper bags

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Shortly after a newly-commissioned Hospital Sterile Supply Unit (HSSU) opened, it was noticed that the striped indicator patches on the dressings bags sometimes failed to alter in colour from pink to dark brown even though the sterilising process to which they had been subjected appeared to be satisfactory. Subsequent investigations showed that this failure was due to the presence of superheated steam in the autoclave chamber.

Since it appears probable that superheat in modern autoclaves may be more common than is generally realised, we describe the incident and the means by which the conclusion was reached that superheated steam was the cause of the failure.

Materials and Methods

HSSU. This is a new unit in a recently built district general hospital. It is intended that eventually this HSSU will supply all the hospitals, clinics and Health Centres for which the Area Health Authority is responsible. Meanwhile its output is supplemented by work which is processed at the old Central Sterile Supply Department (CSSD) premises about half a mile away.

Thermocouples were of Copper/Constantan, 0.2mm in diameter and insulated with PTFE. They were used in conjunction with Chessel recorders.

Spore Papers were prepared by Southern Group Laboratories and were supplied by the Department of Health and Social Security. They were distributed in various parts of the autoclave chamber, some fully exposed to the steam and others inside units of the load. On completion of the cycle they were placed in tryptone soya broth and incubated at 55°C for three weeks.

Paper Bags. These were standard heat-seal closure sterilisation bags meeting the DHSS specification and supplied by Smith Bros (Whitehaven) Ltd against DHSS contract No. R/P 1058/123C. For the purpose of the experiments described only Code 'Q' and Code 'R' bags were used, although the colour change problems encountered were not in practice restricted to these two sizes.

Results

When the investigation of the failure of the striped indicator patches to change colour was started, the HSSU staff had already made some significant observations. Thus it had been noted that failures, when they occured, were always in bags making up the top layer in the load; that failures were confined to the autoclaves in the HSSU and did not take place in the CSSD even though similar bags from the same supplier were being used there; and that covering the top of the load with a single sheet of wrapping paper was enough to ensure a satisfactory colour change. Finally, when failures had taken place, it was found that re-autoclaving the packs would not produce a satisfactory result — the packs had in fact to be repacked in fresh bags.

Thermocouple measurements made in the load and in the free space of the chamber during normal operating cycles showed a temperature gradient, which increased from the bottom upwards to reach a maximum in the void above the load of some 6-14°C above that of the lower parts of the chamber and of the chamber drain. These differences, to a greater or lesser extent, were demonstrated not only in the holding stage but also in the prevacuum, steam pulsing and drying parts of the cycle. A typical thermocouple tracing is reproduced in the figure. From this it can be seen that there is an element of superheating of about 14°C at the commencement of the holding period in the chamber void above the load and that this is only just abated by the end of the holding period.

An experiment was devised to test the hypothesis that it was this superheat in the upper part of the autoclave which was responsible for the failure of the indicator stripes on the bags to change colour. Striped areas were cut from bags (of Code Q size) and wrapped, with the stripes outwards, around the lower part of a 150 × 15mm test tube, being held in place with a small piece of adhesive tape. The tubes with indicator stripes in place were then heated in a fluidised sand bath, held at 140°C, for periods ranging from one to five minutes. The strips were then mounted on a sheet of paper together with an unheated control and autoclaved in the lower part of one of the HSSU autoclaves. The results are shown in the table below:

Duration of preheating at 140°C	*Colour of stripes after autoclaving*
1 minute	Mixed red and black areas
2	Mixed red and black areas
3	Red
4	Red
5	Red
0 (unheated control)	Black

None of eighteen *B stearothermophilus* spore papers subjected to the autoclaving process showed growth after incubation at 55°C for 21 days. (Control papers which had not been autoclaved showed growth after 24 hours).

A last observation served further to exonerate the indicator stripes on the bags. Over a seven-day period twelve bags, the indicator stripes on which had failed to change, were examined. Whereas stripes on the outer bags (Code R) were either wholly pink, or substantially so, the stripes on all the inner bags (Code Q) of the double wrapped items had made a satisfactory colour change.

Discussion

That failures did not take place in the old CSSD equipment can be explained by its distance from the main steam boilers which is such that wetness rather than superheating of the steam supply could be expected there. Representatives of the bag manufacturers state that the usual cause of the stripe failure is superheating but that occasionally, and not surprisingly, very wet steam can produce the same result. They confirm that the dye in the stripes once heated in the absence of moisture becomes 'fixed' so that it is unable subsequently to change colour. It is of interest that the HSSU operated for some three months before the bag stripe failures were noted. One possible explanation for this might be the effect of the lower humidity of the air on the water content of the paper bags as the change from autumn to winter occurred — the HSSU is supplied with filtered warmed air which is not humidified. A more likely possibility might be that the dryness of the steam supply increased as more boiler capacity was brought into use to augment a supply which would otherwise have been insufficient for winter needs.

There was no evidence of failure to sterilise as judged by the results of the tests on spore strips which had been included with the loads. However, superheating has long been recognised as a cause of sterilisation failure (Report, 1959) and, as such, needs to be identified where it exists, even when, as in this case, it was neither major nor total. In this connection, it is of interest that the indicator failure at first held to be an error resulting from a fault in the ink used to make the stripes was in fact shown by investigation to be a correct indication of unsatisfactory conditions existing in the autoclaves themselves.

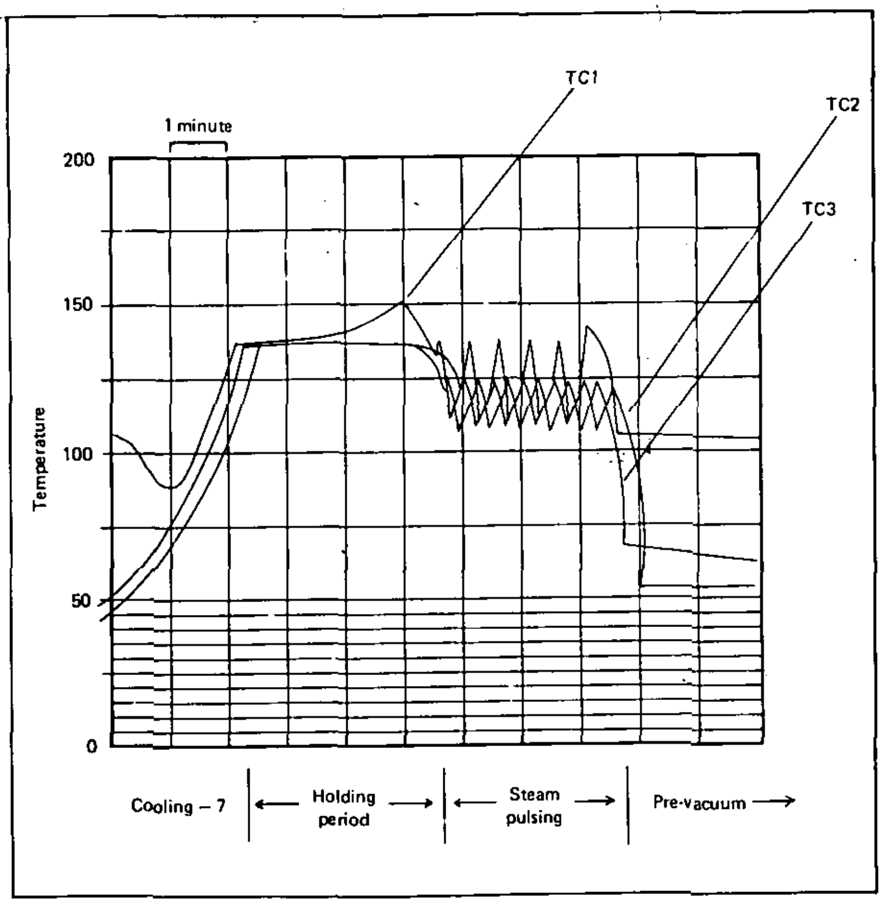
Summary

The failure of the indicator stripes on paper bags to make the appropriate colour change on autoclaving has been shown to be caused by superheated steam in the autoclave chamber.

Such incidents deserve investigation since, apart from the financial loss in time and material occasioned by the need to re-bag items of the load for processing, again there is always the possibility that the failure of the indicator stripes to change colour is correctly signalling a malfunction of the autoclave not previously suspected.

Reference

Medical Research Council Working Party, 1959. A Report. Lancet, *1*, 425.



Temperatures recorded during a sterilising cycle in the upper part of the autoclave chamber (T.C1) in the lowest part of the chamber (T.C2) and in the centre of the load (T.C3). The record commences on the right.

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Site Generation for Hospitals —the concept

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I remember at a Project Team Meeting for a new District General Hospital, an Area Medical Officer saying to me: "We're not building this place for you to show off your technical know-how but for the benefit of the patients". This is something that possibly all of us should remember when considering such things as site generation, and other items of what many consider to be sophisticated engineering. But on the other hand, it is up to us as engineers to offer the various Health Authorities for whom we are preparing the design something which will offer them the maximum security of essential supplies with the most economic working possible. These days, as we all know, energy conservation is a matter over which we are all very concerned. I would suggest to you that the system we are discussing will be a means of ensuring the most economic use of what is becoming a very expensive commodity. In fact, apart from salaries and wages, it is the most expensive single item in any Health Authority's budget. *Diagram 1* illustrates the breakdown of expenditure for a typical medium to large Health Authorities.

The next question we must ask ourselves, having established the need for economic operation, that is if we ever doubted it, is where and how is this energy used? *Diagram 2* illustrates typical design figures for a large 800-bed DGH. These figures are based on the maximum demands for a city development where, as you know, it is essential to make the most economic use of land. This probably indicates the need for a high rise development, several core departments and, if we are really to obtain a good site cover, limited use of light wells and courtyards however desirable these may be in theory. These needs will account for what some readers may consider to be high requirements for air cooling and lighting.

In my opinion, having carried out several exercises on behalf of my Authority, it is difficult to decide on the use of energy distribution other than as steam for a major development. Steam generation offers many advantages over its alternatives such as Hot Water distribution either as High Pressure, Medium Pressure or our standard of Low Pressure.

One of the main advantages must be the cost element. I would suggest that the steam boiler in the size of plant we are considering for the hospital, of say up to 40,000 lbs/hr installed capacity, is the only plant that can burn low grade fuel such as heavy oil properly. I don't think many of us would be happy to see heavy oil burned in a hot water boiler under an equivalent size of say 25,000 lbs/hr.

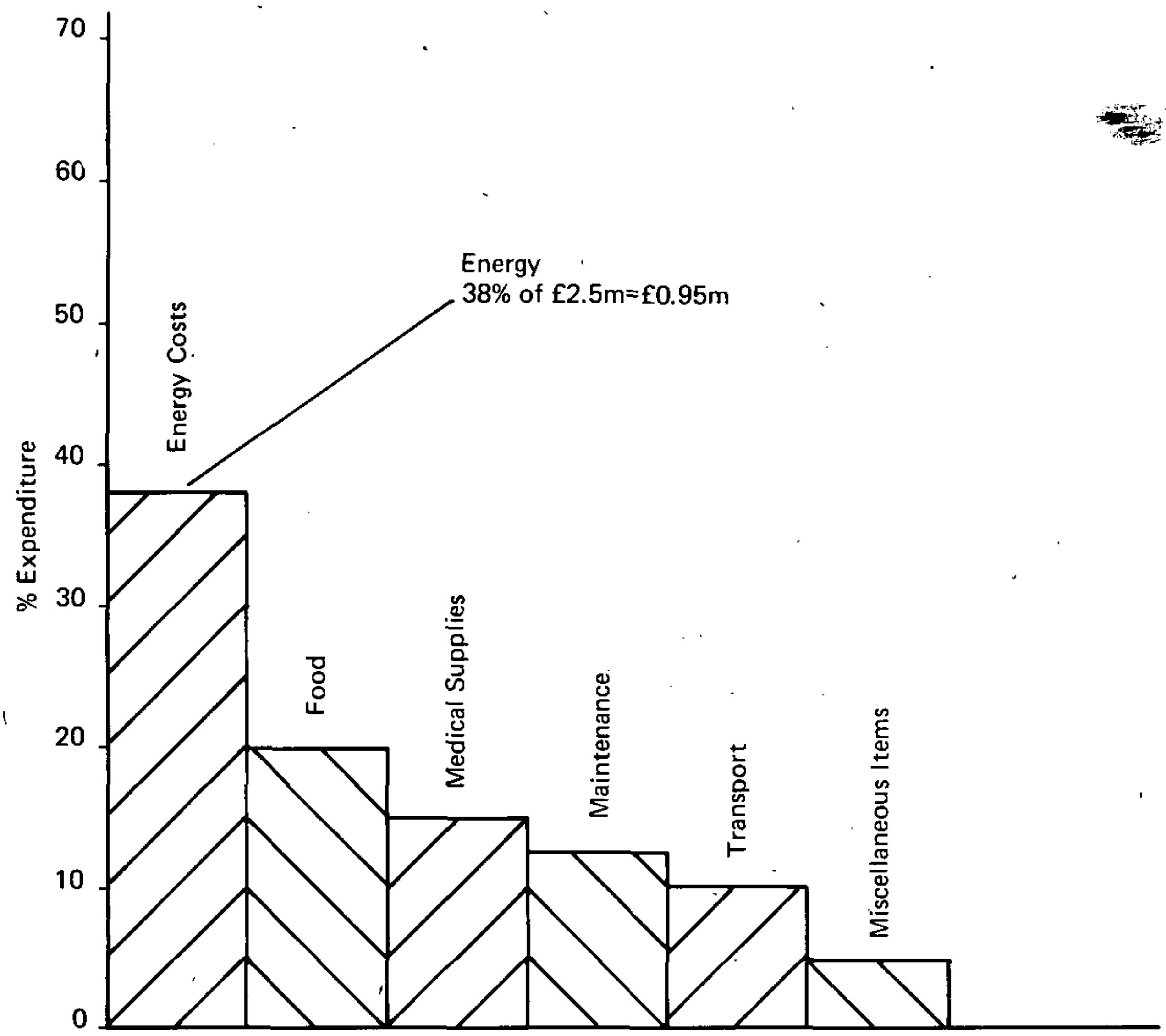
If we think of the cost aspect, heavy oil (3,500 sec) is averaging at 13.6p/Therm output, gas oil at 16.9p/Therm output, and natural gas at 16.6p/Therm output. The alternative is of course coal, which is probably the cheapest fuel basically, but there is a lot more auxiliary plant to be considered. Here again, I would suggest that a steam boiler will burn coal more efficiently than its equivalent size water boiler. Of course, we all appreciate that the situation is such that at present coal is not really the primary fuel that it was. This is because of other problems, such as the auxiliaries needed which have to be maintained, the fact that it is (in the hospital context) more labour intensive, and the difficulties of dust emission control. This again is not a problem on big plants such as power stations, but difficult on our size of plant, so really we are left with the oils or gas.

As many of you will know, the current cost of steam generation to the Health Authority is now in the order of £2/1,000 lbs. I remember when I joined the Health Service some 14 or 15 years ago, we used to look very carefully into any hospital where the cost exceeded 10/- (in old money) per 1,000 lbs. This, I think, further confirms the need to obtain the maximum utilisation of the heat energy in that steam.

The second point we must consider is the need to protect at all times the essential electricity supplies of the hospital. We have, of course, been fortunate in that, through the good offices of the various Supply Authorities, we have been comparatively untouched by such matters as working to rule, overtime bans and labour disputes. This does not mean we can assume this situation will continue. I would suggest that in the future we could be very much at risk. There is always the possibility that a change of Government could see a hardening of attitudes and a change in industrial relations. These changes are likely to take place in the short term, whereas in planning the hospital we must be looking ahead for perhaps forty years. I would suggest that in this context we could be at risk if we do not protect the hospital for a possible shut-down of electrical supplies through industrial action, or indeed for any future change that may affect the security of the electrical supplies.

There are the unforeseens against which no one but ourselves can offer protection. These include weather problems, accidental damage to mains cables, etc. I think we are all agreed on the need to provide cover for the

Diagram No. 1 Typical Breakdown of Health Authority Expenditure—Excluding Salaries.

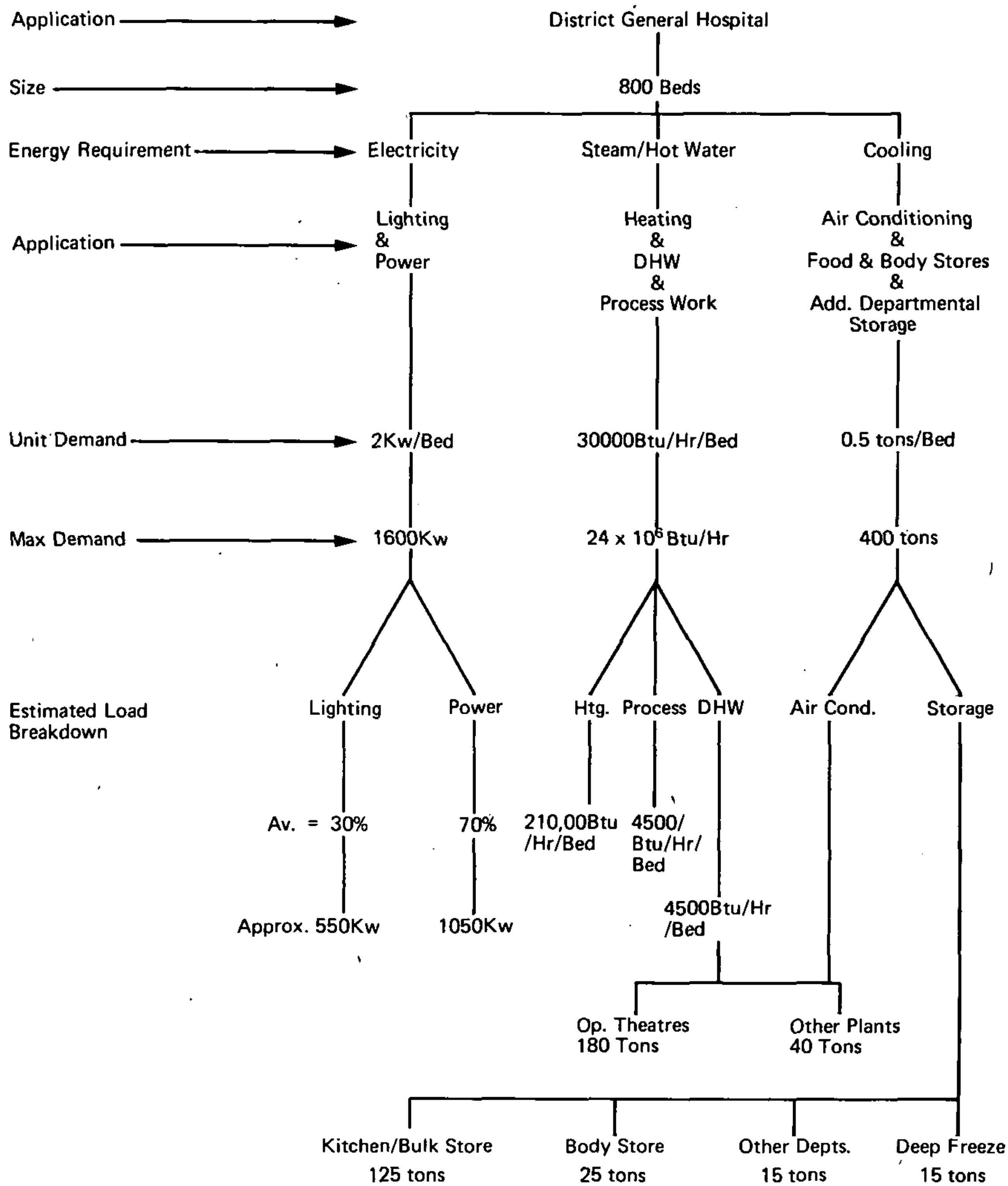


essential services at all times, even to the extent of covering ourselves for the once-in-ten years breakdown. The only way this can be done is by providing sufficient generating capacity on site to cover our essential load.

Diagram 2 does show the breakdown of the various loads into the essential and non-essential components. These days, with the continual build-up of electrical equipment in the modern hospital, the essential and non-essential are becoming to some extent blurred. I would suggest that in ten years' time we could see the esential load well exceeding the non-essential. At present our investigations indicate that in the modern sophisticated DHG or specialist unit the breakdown is roughly fifty-fifty.

There is also an increasingly large demand for what one might term low grade heat energy for process loads. Here one can consider calorifier plant, particularly that used for the production of domestic hot water, and refrigeration to provide for the cooling associated with the increasing demand for air conditioning. I have always been a supporter of cooling. I know many readers may take issue over the need for refrigerated cooling, but when one considers the cost of installing the basic plenum plant with its lengthy duct runs, high quality filtration and probably humidification, together with the sophisticated control systems, the additional costs of adding cooling are quite small. Particularly, I would suggest that this additional cost can be justified when the demand for full air conditioning is considered. After all, ten years ago it was very doubtful if one could find many ITUs with full air conditioning, leave alone cardiac units, prembaby units and the non-patient areas, such as CSSDs, sterile products units and X-Ray Departments. I am sure many of you who are associated with the planning of the modern hospital will be only too aware of the demand for air conditioning to be added to many departments such as those mentioned. If one brings it down to a straight question of money, there is the increase in the working efficiency of those employed in the department that it is now accepted that a good working environment can bring.

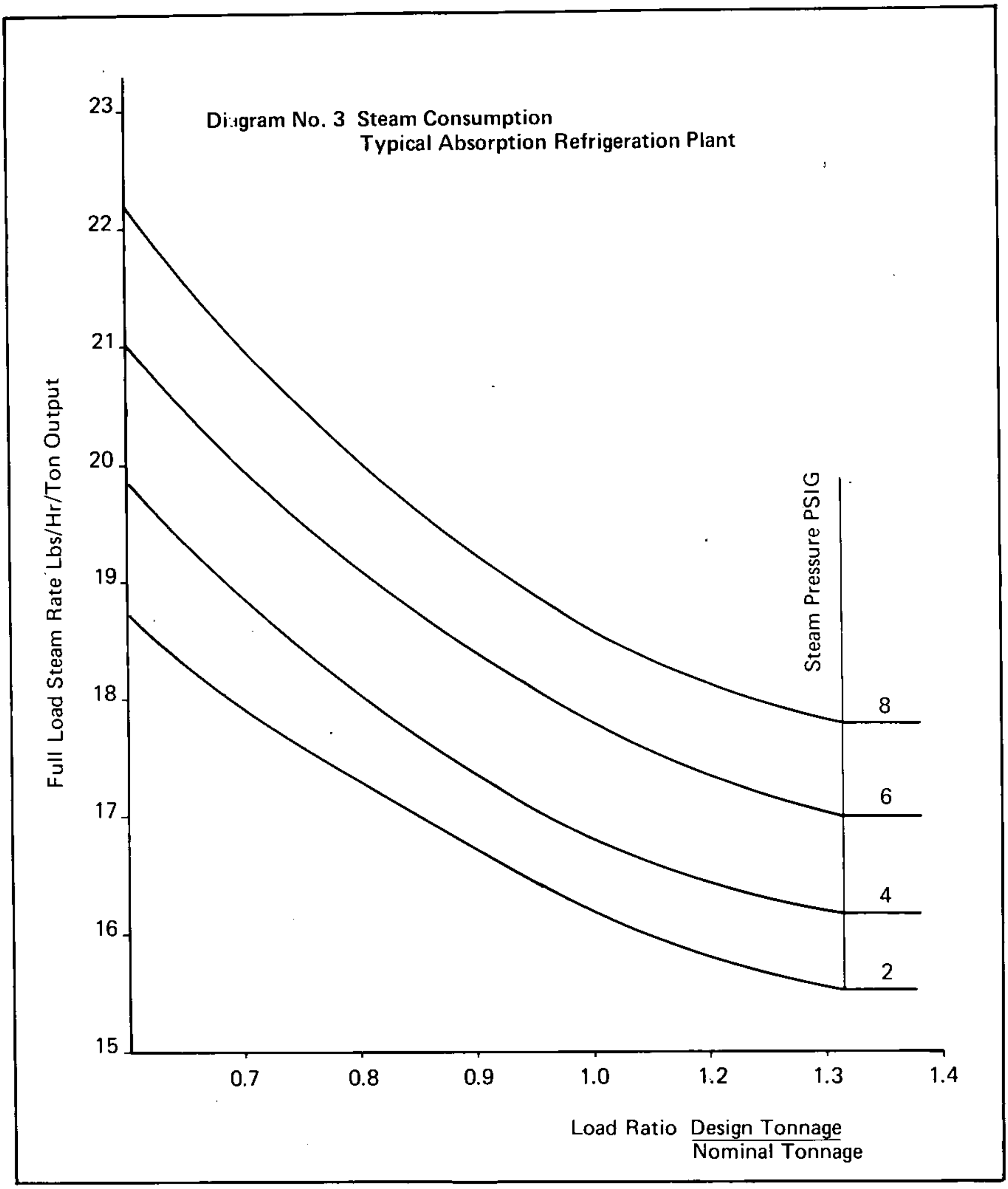
Energy Use Diagram Diagram No. 2



Many of us must have been appalled to see modern office blocks where air conditioning with cooling is accepted without argument, whilst one has to face lengthy argument and discussion over the need to include it in the modern hospital.

If one accepts, as readers will appreciate I have, the need for increasing use of full air conditioning, there is the question to be considered as to the most economic method of providing that air conditioning. I am quite convinced that the answer lies with the absorption refrigeration unit.

It offers high and steady output, a minimum of working parts and, to the man who is faced with the task of keeping things going, very limited maintenance involvement when compared to the conventional reciprocating or screw compressor. The principle of its operation is an energy input in the form of heat, and it is generally recommended that the most satisfactory method of providing this heat input is by steam. With the absorp-



tion unit, the quality and pressure of the steam is not of major importance, so we have another item of plant which can utilise what one could term 'second class' steam.

The steam demand for a typical absorption unit is in the order of 20 lbs per tonne of refrigeration. The steam demand equated to refrigeration output is shown on *Diagram 3*, and on the basis of the maximum demands shown on *Diagram 2*. I have indicated the maximum steam demand, which can be seen is in the order of 3,740 lbs/hour.

The thing that one must appreciate is that it is frequently necessary to consider the application of cooling on an all-year basis rather than for a limited summer period only. This is because much of the heat gain in the departments arise more from equipment than it does from the sun.

So there we have the basis of our equation. The need to provide security of essential electrical supplies and a reasonably constant low grade steam demand. A further point which can add a great deal to the economic operation of the whole hospital's services is peak lopping.

To consider this in a little more detail — as you will know, the majority of public supply authorities operate a two-part tariff that consists of a fixed annual charge of £X per Kwh of maximum demand, plus a charge per Kwh consumed. The economies of the situation can be improved very considerably by generating part of the hospital load to reduce the isolated peaks on the demand curve. Generally, if one uses the standby diesel generator at periods of heavy demand, it works out in practice that the cost per Kwh for power generation is higher than that charged by the supply authorities.

Not many hospitals show substantial peaks in electrical demand of short duration in their load pattern, but this naturally depends on the extent of use of electrical power. For example, if the main kitchen equipment should be mainly electrically heated then one could expect a definite peak between, say, 10.00-12.30 or thereabouts. The simplest method of peak lopping will be to bring in the standby diesel generator manually, which means that one has to be very careful in selecting the proportion of the load that the generators carry. For example, it would be unacceptable to transfer the theatre load because of the delays which will occur when the standby plant accepts or relinquishes its load. This period is not likely to exceed ½-1 minute, but as will be realised this could be long enough to cause patient discomfort. However, one can divide the hospital load into 'essential' and 'non essential' supplies and take separate circuits back to the main switchboard where they are connected by a busbar coupler. The generators are then connected to the essential side via circuit breakers. In the event of supply failure, the coupler opens, the generators start up and feed the essential circuits.

This is the basis of the system which is in current use in the Welsh region:

Considering the items outlined in detail, I would offer the following detailed explanations:

Site Generation

We are considering the utilisation of process steam and, therefore, the limitation of the amount of site generation to provide a balance between the demand for electricity and that for low grade process heat. The ultimate is, of course, total energy, but we are not as yet at that stage. Whilst it is of obvious advantage for a hospital to generate its own electrical power and to be virtually independent of external supplies, to provide an economic justification the power must be generated at the same or lower cost than the current tariff, taking into account the fixed maximum demand charges of the public supply authority.

Many engineers have questioned whether this is ever possible because of the very much lower efficiency of, say, a 2 MW plant compared to that of the 500 MW plants now in use in the generating stations. However, I would suggest that special circumstances prevail in the hospital which not only enables this system to be adopted as an engineering principle, but which also offer this service as an acceptable economic solution.

The first requirement must of course be that the hospital has a major steam raising plant. The standard practice is to include steam plant where there are requirements for sterilising and laundry services as well as the standard requirements of heat-using equipment such as kitchens, general heating and hot water supply. Apart from the necessity of providing steam on the site, I would suggest that the big, by hospital standards, modern steam raising plant is the most efficient and economic, and has the advantage that it can use heavy oil as well as gas or solid fuel. The distribution of steam at the current hospital pressures of 120-150 psig is probably the most economic as regards capital costs, because of reduced mains sizes when compared to the available alternatives. I would also suggest that it offers reduced maintenance costs over its likely alternative of medium or high pressure hot water. Whilst we normally generate steam at 150 psig, and possibly have our main distribution network at around 120 psig ,the majority of the steam-using equipment operates at 20-50 psig, with the exception of the sterilising plant. Steam required at the lower pressures is produced from the high pressure network by local reducing sets.

Probably the biggest single steam-using plant in the hospital is the calorifier plant which is required to provide both heating and the hot water services.

On the analysis given in *Diagram 2* the usage for an 800-bed DGH will be 24,000 lbs/hr of steam, of which about 17,000 lbs/hr is required for heating, 3,500 lbs/hr for process work, and a further 3,500 lbs/hr for hot water. It is usual practice in the hospital to supply this steam at about 25-30 psig, but calorifiers are readily available which operate on lower pressures, in fact down to 5 psig. The only real difference being the larger battery size and consequently a slightly larger overall calorifier.

The obvious question that requires answering is why use pressure reducing sets?—why not substitute a steam generator for the reducing set, and produce a balanced electrical output to that of the steam demand for the calorifier plant?

If it is agreed that the inlet steam pressure to the engines is at the line pressure of 120 psig and the engine exhausts at 5 psig, then it will generate 1 Kwh of electrical power for every 40 lbs of steam available. Thus, for the case under discussion with a calorifier steam requirement of 24,000 lbs/hr, it can be expected that the equating generation would be 600 Kw.

If we include the steam requirements for the absorption refrigeration plant, which on the example are estimated at $220 \times 20 = 4{,}400$ lbs/hr, then we arrive at an LP steam demand of 28,400 lbs, which on the basis stated gives an estimated generator output of 700 Kw. This would cover the essential electrical supply demand of the unit under consideration.

It is on this basis that I would submit that the hospital steam driven generator plant can compete economically with the public supply. The principle reason is that, in the power station steam as exhaust from the turbines is (apart from that required for a few auxiliaries) condensed and then discharged into some convenient lake or river, or in the case of inland stations, ejected from the cooling tower. This indicates that some 60% of the total heat available in the steam is wasted. With the plant we are considering, the process load replaces the condenser and the equivalent of the ejected cooling water is usefully employed.

The layout for a typical plant is shown on *Diagram 4*. In this layout steam is admitted to the engines at 120 psig dry saturated and exhausted to the process load at .5 psig with a dryness fraction of 0.91-0.92.

The electricity generated is dependent upon the demand from the process load during normal operation when the public supply is available. The quantity of steam entering the engine is controlled at the governor valve by the back pressure control from the low pressure steam header to the process load. The total demand for electrical power will be in excess of the generator output, and the balance can be taken from the public supply.

Should the public supply fail, then there is automatic opening of the busbar coupler between the essential and non-essential supply 'live' but fed from the generator. The opening of the busbar coupler will also disconnect the back pressure control and the engine main steam valve. This has the effect of enabling the generators to adjust their output to meet the essential supply load. There will, of course, be a matching steam load which will be in excess of that required by the process load and the excess can be blown to atmosphere via low pressure relief valves. It will be appreciated that this arrangement only becomes effective on failure of the public supply and, therefore, the cost inherent with the waste of exhaust steam is secondary to the main consideration of keeping the hospital operational.

When the public supply is restored it is usual to remain with on-site generation for a short period, feeding the essential circuits and to allow the public supply to feed the non-essential circuits only. This enables the restoration of full public supply to be established and provides a period which it is possible to ensure that the fault is not intermittent and reoccurring.

Once satisfied that the public supply is satisfactory, then the system can revert to the original mode of operation and the load adjusted accordingly.

When one is considering the case for this system, there must always be some form of electrical standby supply. HTM No 11 which deals with Emergency Electrical Services recommends that adequate provision is made to cover essential supplies. I would, therefore, suggest that consideration of the economic case for the type of plant described should start where the normal diesel generator standby ends. In other words, our capital is only that difference between the diesel sets and the larger steam driven sets. Similarly, when assessing the revenue case, one need only look at the difference between the revenue commitment for the diesel sets and that of the larger steam sets. Additional steam costs will similarly be those associated with the difference in steam usage for the two systems at the calorifier and absorption units.

I would agree that there is an additional space requirement for the steam driven generator, and a small increase in space for the calorifier plant. Extra space is also needed for the absorption refrigeration, when compared to a screw compressor — which would probably be the alternative for this size of load.

The Thermodynamic Aspects

The thermodynamic aspects of the case are based on the following assumptions:

1. Radiation losses are maximised at

Using Reducing Sets to Feed Calorifier Plant

Total heat in Steam at 135 psi absolute (This is 120 psig)	= 1,195 BTU/lb
Heat in Condensate to Hot Well (Assumption No 2)	= 180 BTU/lb
Available Heat	= 1,015 BTU/lb
Losses through Radiation (Assumption No 1 — 5%)	= 51.5 BTU/lb
TOTAL HEAT UTILISED	= 963.5 BTU/lb
= 963,500 BTU ∴ Heat usefully utilised/1,000 lbs	

By-Pass Steam from the Steam Driven Generators

Total Heat in Steam at 135 psi absolute (This is 120 psig)	= 1,195 BTU/lb
Exhaust steam pressure from engine	= 20 psi absolute =5 psig
Manufacturer's Data — Dryness fraction	= 0.9175
Expansion is therefore polytropic and from the Heat/Entropy Chart the true heat content of the exhaust steam is:	= 1,075 BTU/lb
∴ Heat passed to Calorifiers	= 1,075 BTU/lb
Heat in Condensate to Hot Well	= 180 BTU/lb
Available Heat	= 895 BTU/lb
Radiation Losses at 5%	= 44.75 BTU/lb
Total Heat Utilised	= 850.25 BTU/lb
∴ Heat usefully utilised/1,000 lbs	= 850,250 BTU

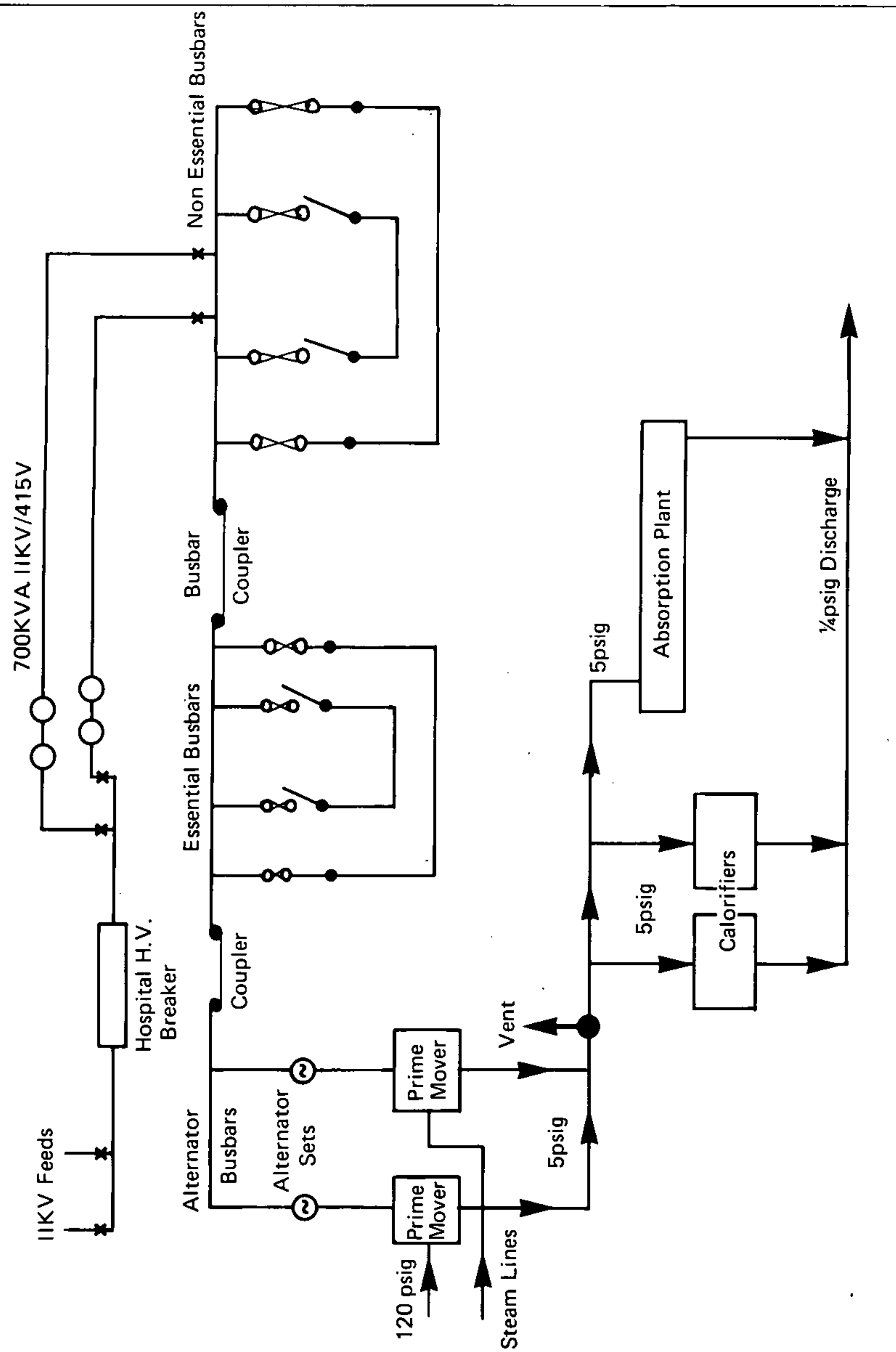


Diagram No. 4 General Arrg. of System of Site Generation

5% of the heat utilised in the process plant;

2. The heat in the final condensate, ie that leaving the process plant and entering the hot well, has a residual heat energy of 180 BTU/lb;

3. The figures quoted for steam conditions and usage are based on those supplied by Messrs Bellis & Morcom Ltd, whose engines are used for these schemes within the Welsh Region;

4. It is assumed that there will be no drop in efficiency of the calorifiers when utilising the reduced pressure steam;

5. Steam will pass to the reducing valves at 135 psig. This will only occur when the generators are not in use;
6. The cost of steam generation is £2/1,000 lbs.

The details given in this paper are based on per 1,000 lbs of steam used. My colleague, Mr Griffiths, gives a detailed case history based on the operation of an actual plant in his article "Conservation Through Site Generation". The details I have given represent the theoretical case whilst Mr Griffiths' paper will refer to actual practical operation of a plant.

Equivalent quantity of steam to pass through the generator to provide the same heat content from the engine exhaust as that provided by 1,000 lbs of steam via reducing valves:

$$= \frac{963,500}{850.25} = 1,135 \text{ lbs}$$

Therefore, an additional 135 lbs of steam are required by use of the generators in place of reducing valves. but 40 lbs of steam will generate 1 kWh of electricity:

$\therefore$ 1,135 lbs of steam will generate

$$\frac{1,135}{40} = 28.4 \text{ kWh}$$

The cost attributable to this generation rate is 135 lbs of steam (the difference between 1,000 and 1,135 lbs) and if this is taken at a cost for steam production of £2/1,000 lbs,

$$\text{then Total Cost} = \frac{135 \times 200}{1,000}$$

= 27p/kWh generated

$$= \frac{27}{28.4} = 0.95\text{p/unit}$$

This figure is a theoretical cost which gives the aim. In practice the cost will be increased by some 30%. This is because of increased distribution losses on some older installations, the possibly higher heat conent of the final discharge, the labour element and maintenance costs that one allocates to the site generator, and the general imponderables that always add to one's theoretical figures.

The actual figures of an operation installation will be discussed in the second paper.

Thus, provided steam is required for the calorifier plant, electricity is generated at a cost of 27p/kWh and/or 0.95p/unit. The current recommended tariff shows an Electricity Board charge equivalent to 3p/unit. The savings on the Maximum Demand Charges are naturally dependent upon steam being required at the calorifiers during the periods of greatest electrical demand.

Studies have indicated that up to the present the demand for electrical power has been greatest during the winter months and that during the summer months the electrical demand is least.

I would suggest that this pattern is changing as I have indicated on *Diagram 2* the air conditioning load and the cooling load is increasing, and naturally the requirement for cooling is going to be greatest in the summer months. This would indicate a tendency to balance up to give a more constant electrical demand throughout the year.

On the example shown, the air conditioning refrigeration is estimated at 220 tons. If one uses a standard compressor plant this will indicate an electrical load of 220 Kw.

During the summer period the calorifier demand would be reduced because of the reduction in heating load, but if one considers the 200 Kw for cooling, this would indicate a steam demand of 4,400 lbs/hr. Assuming 10% losses, the heat output from calorifiers using this amount of steam would be 4×10^6 Btu/hr which is roughly 25% of the full winter demand for heating. On this basis, I would suggest that this indicates a further advantage that could be used to assist in achieving a thermal balance.

Some people insist that there is a need to install additional boiler capacity to cover for the additional steam demand of the generators.

This has been calculated at 135 lbs of steam for every 1,000 lbs used earlier in this paper, and on the basis of *Diagram 2*'s demand of 24,000 lbs/hr this will give a total additional demand of $135 \times 24 = 3.240$ lbs/hr. My own view is that on a new hospital with a likely installed boiler capacity of 40,000 lbs/hr to allow for the required standby facilities, there would be adequate power in hand to permit this additional load of under 10% to be carried. However, for the record, and to avoid any complaint of the figures being fitted to suit my particular case, I have based the additional costs on the Department's costs given in Capricode. Thus, the extra costs = $3.24 \times$ £10.000 = £32,400, say £35,000.

Everything these days has to be equated to finance so the 'proof of the pudding' will be in the comparison of present worth cases.

Comparison of Present Worth of Steam and Diesel Generators

The following assumptions are made:

Electrical Tariff = £10/Kw of Maximum Demand + 3p/unit

Power generated by Steam Driven Generators = 2.9×10^6 Kwh/annum

The diesel costs are based on the assumption that 350 Kw sets would be installed.

On this basis, I would suggest that the case for the use of absorption plant in place of a standard compressor installation can well stand on its own. When the economic use of the steam, the benefits of additional site generation and the nearing of the thermal balance are considered, I would suggest the case improves even more.

The ultimate of the case I have discussed in this paper must be a total energy installation. I would very much like to see such an installation in operation and have the opportunity to monitor this carefully and make my own assessment.

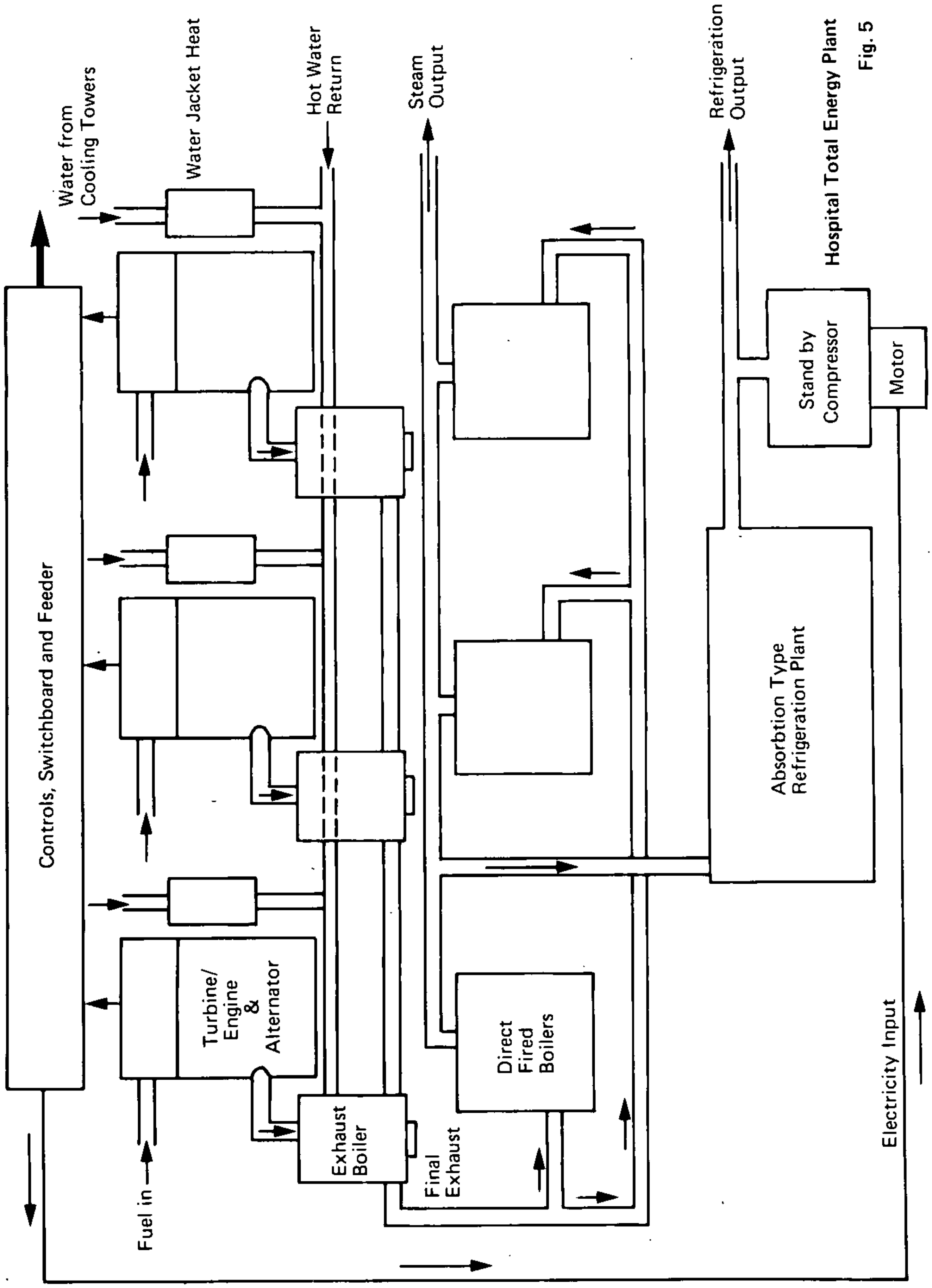
It is unlikely that this will occur under the present financial climate and the tendency to move away from the big 800-1,000-bed DGH to the smaller Nucleus Development.

However, by way of finalisation, I have prepared a diagram of this ultimate (*Diagram 5*). See overleaf.

Present Value Tables	Diesel Driven Generators	Steam Driven Generators
PV of Initial Capital Cost of Generators, Switchgear, etc.	700 Kw at £375/Kw=£262,500	350Kw at £285/Kw=£10,000
PV of Replacement Costs of Installation	RP(30)×Capital Cost =£262,500×0.06=£15,750	RP(30)×Capital Cost =£10³×0.06=£600
PV of Capital Cost of Accom.	1200 sq ft at £10/sq ft =£12,000	825 sq ft at £10/sq ft =£8,250
PV of Replacement Cost of Accommodation	RP(60×Capital Cost =£12,000×0.01=£120	RP(60)×Capital Cost =£8,250×0.01=£82
PV of Additional Boiler Power	£35,000	
PV of Replacement Costs of Extra Boiler Power	RP(25)×Capital Cost =£35,000×0.1=£3,500	
PV of Annual Running Cost	Labour & Maint.=£1,500 Kwh Generated=$\frac{2.9\times10^6\times0.95}{1,000}$ =£27,550 PV=YP(00)×Cost =£29,050×10=£290.500	Labour & Maintenance=£150 YP(00)×Cost £150×10=£1.500
PV of KM Charges per Annum		$2.9\times10^6\times3/100$ =£88.800/annum PV=YP(00)×Cost =10×£88.800=£888.000
PV of MD Charges per Annum		=£10/Kw say £13,000 PV=YP(00)×Cost =10×£13,000=£130,000
TOTAL PV OF SCHEME SAVING	£617.370 £420,462	£1,037,832

Present Worth Comparison of Compressor and Absorption Refrigerator

Based on 100 Tons Capacity	Compressor Plant	Absorption Plant
Capital Cost	£8.000	£11,000
PV of Replacement Cost of Installation	RP(15)×Capital Cost =0.31×£8.000=£2,480	RP(20)×Capital Cost =0.17×£11.000=£1.865
Operating Cost/Annum		
Electricity	98.8 Kw Cost=£2.700	0.4 Kw Cost=£12
Water	809.424 Galls. Cost=£125	7,627,200 Galls. Cost=£1,552
Maintenance	Cost=£2.000	Cost=£500
Total Operating Costs	Cost=£4,825=£4.825	Cost=£2,064=£2.064
PV of Operating Costs	YP(00)×£4.825 =10×£4,825=£48,250	YP(00)×£2,064 =10×£2,064=20,640
TOTAL PV OF SCHEME SAVING ON PV	£63.555	£35,569 =£27,986/100 Tons installed capacity
TOTAL SAVING		=£27.986×2.2 =£61.569



Hospital Total Energy Plant

Fig. 5

Classified Advertisements

APPOINTMENTS AND SITUATIONS VACANT

DERBYSHIRE AREA HEALTH AUTHORITY
CENTRAL DERBYSHIRE DISTRICT

MANOR HOSPITAL, Uttoxeter Road, Derby

DISTRICT WORKS DEPARTMENT

Engineering Electronics Technician

(MEDICAL PHYSICS TECHNICIAN GRADE II)

An Electronics Technician is required to start up and head an electronics and specialist equipment maintenance unit. The Technician will be expected to undertake the planned and 'Breakdown' maintenance of all types of electronic systems and patient orientated equipment. Experience of equipment and machinery used in health care would be an advantage. The Technician will be responsible to the District Engineer.

Qualification requirements: HNC, HND, or Degree in Electronic Engineering or equivalent.

Salary scale: £4,063 to £5,137 pa (increase pending). Write or telephone for an application form from District Personnel Officer, Boden House, Main Centre, Derby. Tel Derby 362321, Ext 55.

For further details or information telephone Mr. C. Marshall, District Works Officer, Derby 371071, Ext 528. Ref No. 2025.

WILTSHIRE Area Health Authority
Swindon Health District
DISTRICT WORKS DEPARTMENT
BURDEROP HOSPITAL

Assistant Engineer

The successful applicant will be a member of a design team involved in the production of specifications and drawings for minor capital and major maintenance schemes within this Health District. The post offers excellent experience in the design and implementation of schemes to completion and is a good lead into the field of hospital maintenance.

Prospects are good and there are further study opportunities available for a young, ambitious Engineer.

Applicants should have served an apprenticeship or have obtained a thorough practical training in electrical or mechanical engineering, and must possess an ONC in Engineering or equivalent qualification.

Salary scale: £3,888 rising to a maximum of £4,377.

Application forms and job description available from the District Personnel Department, Princess Margaret Hospital, Okus Road, Swindon, Wiltshire. Telephone: 36231.

Closing date for receipt of applications: August 24, 1978.

CROYDON AREA HEALTH AUTHORITY
Area Engineering Services

Assistant Engineer

(male or female)

for duties on an Area basis but based initially at Area Works Department, Queen's Hospital, Queen's Road, Croydon.

Applicants should possess ONC in Engineering or an equivalent qualification.

Salary scale: £3,063 pa rising to £3,507 pa. Suitably qualified and experienced candidates may commence at £3,285 pa London Weighting of £354 pa and Supplementary Allowance of £291 pa is also paid plus 5% Supplement — minimum £130 pa maximum £208 pa. This post offers excellent training for Engineers wishing to make a career in the Hospital Service. Pay award under negotiation.

Applications stating age, qualifications/apprenticeships, full details of previous experience, together with names and addresses of two referees (current/previous employers preferred), who will be contacted if called for interview, to Area Personnel Officer, General Hospital, London Road, Croydon CR9 2RH, quoting ref: AWO 20.

Closing date for applications is: August 19, 1978.

DERBYSHIRE AREA HEALTH AUTHORITY
CENTRAL DERBYSHIRE DISTRICT

MANOR HOSPITAL
UTTOXETER ROAD, DERBY

DISTRICT WORKS DEPARTMENT

MEDICAL PHYSICS TECHNICIAN GRADE 3

Required in a new unit to maintain electronic systems in both engineering and health care equipment plus maintenance of specialist patient orientated equipment.

Salary: £3,401 pa rising by seven annual increments to £4,318 pa (increase pending).

Responsible to an Engineering Electronics Technician Grade 2.

Qualifications: ONC, HNC, HND or Degree in Electronic Engineering or Physics or equivalent. Three years as a Grade 4 Technician or comparable experience an advantage.

For further details contact: Mr. C. Marshall, District Works Officer. Tel. Derby 371071 ext. 528. Ref No 2031.

Application forms and job descriptions, in respect of the above post available from the District Personnel Department, Boden House, Main Centre, Derby. Tel. Derby 362321 ext. 55.

To place an advertisement in the next issue of **HOSPITAL ENGINEERING**, appearing on **September 1, 1978**, please contact: **EARLSPORT PUBLICATIONS**, 17 St. Swithin's Lane, London EC4, 01-623 2235/8, by **August 22.**

Closing Dates

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