HOSPITAL ENGINEERING

November 1978

The Journal of the Institute of Hospital Engineering

Engineering Building Services for Nucleus Hospitals

THE HOWORTH ACTIVE SCAVENGING SYSTEM FOR ANAESTHETIC GAS POLLUTION

The Howorth anaesthetic gas scavenging system is an active system designed specifically to reduce air pollution by anaesthetic gases to well below the maximum levels recommended by NIOSH in the USA and by the British Association of Anaesthetists in the UK. The system complies with the principles of DHHS Circular HC(76)38.

SYSTEM CHARACTERISTICS

High Volume, Low Pressure

The high volume ensures high dilution of gases and all moisture, thus avoiding explosion risk and any condensation within the ducts.

No excessive or dangerous suction pressure can be exerted on the anaesthetic machine circuits.

There is no imbalance of pressure if only one extract point is being used on a multi-point system.

Active

Unlike passive systems, mechanical scavenging is effective under all conditions of pipe runs and outside wind pressures.

Break Point Connections

These are designed to limit the suction pressure on the machine circuits to the required and recommended limit of 0.5 cm/H_2O.

They cannot be occluded accidentally.

They are compatible with 18mm, 22mm or 30mm extract hose and they are capable of exhausting peak flows of up to 300 litres per minute.

Multi-Purposes Application

The system is designed to cope with extracts from anaesthetic rooms and also to exhaust the patient's breath in recovery rooms.

Versatility of Layout Design

The system can be adapted to scavenge simultaneously, for example, four anaesthetic machine points, or three or four recovery room points, or combinations of machine and recovery room points.

Each extract point is fitted with a self-closing valve which enables alternative extract points to be installed on the same fan system.

Inbuilt Safety Factors

A failure light on the control and indicating panels is activated by an air flow sensor fitted to the fan.

The fan motor is outside the air stream, and the fan blades are of non-ferrous material.

Should the fan motor fail, the system can still operate, as a temporary measure, as a passive system without adversely affecting the anaesthetic circuits.

Typical Test Results

Hospital 'A'

Operating Theatre—	no scavenging: 600-1,000ppm N_2O
	passive system: 230-300ppm N_2O
	Howorth system: 0-3ppm N_2O
Comment:	The 3ppm were traced to leaks in the anaesthetic circuitry.

Hospital 'B'

Operating Theatre—	no scavenging: 800-1,000ppm N_2O
	Howorth system: 0-6ppm N_2O
Comment:	The 6ppm were traced to a leaking cuff on the endotracheal tube.

We should be pleased to offer any further information on request.

HOWORTH SURGICAIR

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Tel: 0204-71131 Telex: 635242

Design Council Award 1977

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HOSPITAL ENGINEERING

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Neither the Institute nor the Publisher is able to take any responsibility for views expressed by contributors. Editorial views are not necessarily shared by the Institute.

Institute News

1979 Annual Conference

It is with considerable pleasure that we are able to announce that the principal guest, and speaker, at the Annual Conference Dinner will be Señor Eduardo Cætano, President of the International Federation of Hospital Engineering, who will be accompanied by his wife.

Their many friends amongst the Institute membership will be delighted to welcome Mr and Mrs Cætano on this occasion.

1979 Bursary Award Competition

Full details of the 1979 Bursary Competition appeared in the October issue of *Hospital Engineering.*

Entry forms and information are obtainable from: The Secretary, The Institute of Hospital Engineering, 20 Landport Terrace, Southsea PO1 2RG.

Closing date for entries is April 30, 1979.

Committee of Inquiry into the Engineering Profession

The Institute of Hospital Engineering was one of the organisations requested by the Committee of Inquiry to assist in a Survey of Engineers which the Committee determined to undertake in order to attempt to fill some of the gaps in the data base on which they are working.

Accordingly, a small random selection of the Institute's members will receive a form of Survey of Engineering Careers for completion to provide the Committee of Inquiry with statistical information.

The success of the survey in no small measure depends on the response rate and the Committee of Inquiry asks the Institute to appeal for the co-operation of the selected members through the completion of the Survey Forms.

Needless to say, any information given is treated in strict confidence, there will be no way in which individual replies may be identified.

The Falfield 'Keele' Courses' Regalia

As is known, the 'Engineering Management Courses' staged by The Institute of Hospital Engineering at the University of Keele for so many years were transferred to the NHS Hospital Engineering Training Centre in 1976. They are held there each year now, although they are still affectionately referred to as 'the Keele Courses'.

Such is the spirit built up by, and on, these Courses over the years that it has been decided to embark on the procurement of 'Course Regalia' which may be added to from time to time. As a consequence, each of the two Courses held this year has presented candelabra to form a basis for the Regalia. Then the Course Tutors presented a handsome gavel and now Mr J. R. Harrison, President, has most kindly presented a further candelabrum in the name of The Institute of Hospital Engineering.

Members' News

D. J. Wicks, recently District Engineer South West Hampshire Health District (T), has been appointed District Works Officer, Winchester and Central Hampshire Health District.

David Wicks has been a real stalwart in Institute affairs for a number of years, being a past Branch Chairman as well as having held other Branch offices. Many good wishes will go with him in his new appointment.

Winchester's gain is Southampton's loss but, fortunately, the Southern Branch will continue to benefit from his contributions.

Midlands Branch Programme

The following activities and meetings have been arranged for the 1978/79 session:

November 15, 1978
Technical Meeting at WMRHA, 'Noise Control'.

December 5, 1978
Annual Dinner at Highcroft Hospital, cancelled.

January 18, 1979
Technical Meeting at the General Hospital, Birmingham, 'The Implications of Pollution Control and Food Hygiene to the Hospital Engineer—An Environmental Health Officer's View.

February 23, 1979
Afternoon visit to The Worcester Royal Porcelain Co Ltd.

March 8, 1979
AGM at General Hospital, Birmingham.

Any enquiries to C. Smith, Branch Secretary. Telephone: Office· 0926 43491; Home 0926 42237.

North-West Branch Events

November 15, 1978, 6.00 pm, at Astley Hospital (Leigh), 'Waste Anæsthetic Pollution'. Speaker: W. J. Smith, Reg Engr, NWRHA.

December 7, 1978, 6.00 pm, at Bolton Royal Infirmary, a paper on 'Waste Heat Recovery' by Fan Installations Ltd. Joint meeting with CIBS and IPlantEng's.

January 18, 1979, 6.00 pm, at St Mary's Hospital, Manchester, a paper on 'Telephone Services, Present and Future'. Telephone Consultant.

February 2, 1979, 7.15 pm, at Worsley Court House, Branch Annual Dinner Dance.

February 14, 1979, 6.00 pm. Works visit to Pilkington's Glass Works.

March 13, 1979, 6.00 pm, at New Warrington Hospital, a Branch Annual General Meeting and paper on Sterilisation.

April 4, 1979, 6.30 pm, a visit to Whitbread's Brewery, Salford.

May 15, 1979, 6.00 pm, a visit to Holden & Brooks, Sharston and Garston, and paper on Heat Exchangers and Pump Manufacture.

On Saturday, September 9, 1978, members of the Branch, together with friends, visited the British Rail Locomotive Works at Crewe. A party of 32 including 12 juniors were taken around the works and shown the construction of the High Speed Train from beginning to completion.

The visit was most successful and highly interesting, particularly to the youngsters of the party, who were able to clamber aboard the engines, sit in the driving seat, and fulfil a boyhood dream.

It also gave the Chairman and Committee an opportunity to meet and renew acquaintances with members from the South Cheshire and Staffordshire Area.

This is the winning entry in the first Bursary Competition to be held by the Institute earlier this year. The rules of entry to the 1979 competition were shown on page 3 of the October 1978 issue.

Mr. Buckley is the District Works Officer of the Roehampton Health District.

The Development and Training of Health Care Engineers

R. D. BUCKLEY DMS TEng(CEI) MIHospE AMBIM

Introduction

At this time it is perhaps more essential than ever before in the history of Health Care Engineering that the development and training of engineers is debated.

We have seen, since the inauguration of the National Health Service on November 6, 1946, an ever-increasing demand placed on engineers working within and outside the Health Service of the United Kingdom. Few could have imagined all those years ago the advances that have occurred in the modern medical treatment of patients. Today's Health Care Engineer, faced with advanced technology in an organisation which utilises one tenth of our national wealth each year, is very different in outlook from his predecessors. It is, therefore, fitting that serious consideration is now given to the development and training of engineers so that they may contribute to the full in the next two or three decades towards Health Care Services.

Who is to tell what new technological innovation or organisational structure will be demanded of engineers in the future? One thing is certain, and that is that the rate of change will increase and, therefore, engineers will have to learn to adapt quickly to new situations. Thus the question is raised: what methods may be applied in order that engineers may meet existing and future needs?

The remainder of this paper examines the existing situation and the way in the future that Health Care Engineers may be developed and trained.

The Existing Situation

If we look briefly into history, we see that one of the first milestones was the Tyler[1] Report of 1962, on the work, grading, training and qualification of Hospital Engineers. This itself set the pattern which can still be recognised today. However, not all its recommendations were implemented. This was unfortunate for, possibly, some of the problems that face Health Care Engineers inside the Service and to a lesser extent outside it would by now have been largely resolved, if the full recommendations had been carried out.

In particular Paragraph 52 states:—

> 'The young man who has only just completed his basic engineering training and obtained his ONC will not be a fully effective member of the staff. He needs comprehensive instruction coupled with opportunities of practical experience in all aspects of engineering appropriate to the Hospital Service. He should in fact continue his engineering education focused on the specific field of Hospital Engineering. He needs to acquire a knowledge of management and administration and we expect his training to include visits to and/or attachment to other hospitals. Training should also include a short period in the Regional Hospital Board Engineering Department.'

The recognition of practical experience and the development of managerial skills is as relevant today as it was 16 years ago. It is unfortunate that the interchange between engineers from Hospital Management Committees and engineers from Regional Hospital Boards did not in the majority of Regions come to fruition. Perhaps the two most significant factors which prevented this happening were:—

a. the structure of the Service;

b. the growth of professionalism for engineers.

In many cases, it seems that Hospital Management Committees were reluctant to release engineers to undertake the training envisaged. It was not uncommon for them to refuse to allow engineers to gain their basic qualifications. It is small wonder that exchanges between sections of the Service were not encouraged let alone those between outside industry with Health Care Engineering involvement.

During the early and late sixties we saw the desire of the Health Care Engineers to be recognised as professionals in their own right. In this respect the experience that could be gained at Hospital Management Committee level on operation and maintenance was not always seen as a suitable background from which Chartered Engineers could qualify. This must be placed in a period when 'big was best' and large resources were being used on the development of the District General Hospital programme.

Since the re-organisation of the Health Service in April, 1974, it could be said that the situation has improved very little. The same type of organisational barriers still exist between Area Health Authorities and the Regional Health Authorities. In fact, with the recent reduction in public expenditure and the emphasis on reduced management costs, the idea of exchanging staff seems to be even further away. However, as will be described later, the 'swop an engineer' idea is one which could be developed with advantage.

The present situation seems to divide itself into two basic categories:

1. Health Care Engineers employed within the National Health Service;
2. Health Care Engineers working in private practice or manufacturing industry.

Both Technician and Chartered Engineers are employed and have an equally important part to play in each situation. The career path and the structure between types of training undertaken by the two groups does differ considerably. The entry point likewise into the organisation also varies.

The present situation is seen as follows:—

a. **Technician Engineers** are employed at each level within the Service, in private practice and in manufacturing industry. Their job roles vary enormously from situation to situation, but broadly speaking, they have a responsibility to apply proven techniques which are commonly understood amongst experts in differing branches of engineering. The terms or definitions used by many engineering societies in Western Europe and the United States of America for these typical duties are:—

erecting and commissioning of engineering equipment and structures;

operating, maintaining and repairing engineering plant, machinery and services;

locating defects;

testing materials, etc.

In the practice of Health Care Engineering Technician Engineers undertake all variety of duties in the pursuit of Health Care Engineering. They are employed to assist at Region in the design of large capital projects or undertake entirely alone small design jobs of a lesser nature within Area Health Authorities. They also have a very large part to play in the daily management of Works Departments in pursuit of operation and maintenance matters. Likewise in private practice, the Technician Engineer is involved in a variety of projects. It is worth noting that there is little interchange between the Service and the private sector and, so, operation and maintenance problems are not always readily known or understood by staff external to the Service.

Most Technician Engineers start their careers as Assistant Hospital Engineers or as Technical Assistants in Regional Health Authorities. Within Area Health Authorities they are mainly concerned with operation and maintenance contrasted against design of capital works at Regional level.

It should be recognised that Technician Engineers have differing training needs for the various parts of the Health Care Business. Some will require a greater insight into managerial problems and their solutions whilst others will place the emphasis on design of specialist equipment, services or contract procedure.

b. **Chartered Engineers** are employed at all levels within the Health Service. In private practice and industry they are in many ways responsible for technical innovations that effect Health Care Engineering within the Service itself. Although, in certain circumstances, Chartered Engineers and Technician Engineers carry out the same jobs — Sector or District Engineer posts — the bulk of their responsibility lies in the management of the Health Care Engineering Service. These responsibilities can vary between the design of capital projects and the management of design offices to that of operation and maintenance within Area Health Authorities.

At the present time, the DHSS, through its Student Engineer Scheme, sponsors about 15 places each year to provide for this manpower need in in the Regional Health Authorities. Apart from this, entry to the Service is from other public services (the Property Services Agency), private or consulting practice and industry.

It is most apparent in the Health Service that both Technician and Chartered Engineers view the activities of each other in different ways. The divisions can make it seem at times as if the two types of engineer within the whole profession are not one but split into two small organisations.

It seems in practice from a training viewpoint that:—

1. **Technician Engineers** wish to pursue their careers and progress until they can more fully understand the scientific principles behind design and construction. In some cases, they wish to improve their career prospects and promotional pattern by studying for academic qualifications required to become Chartered Engineers. Many Technician Engineers feel that many practical problems could be ironed out if design engineers had spent a little time in their earlier careers on operation and maintenance matters and had entered the Service at that level.

2. **Chartered Engineers** wish to put into practice their acquired knowledge to design new types of Health Care Engineering solutions to meet the latest demands from their medical colleagues. To further their training many newly qualified Chartered Engineers, it is felt, would welcome a period at operational level to gain practical experience, but they are prevented by the present structure of the organisation and professional requirements from doing so. Likewise in the private sector, it is even more difficult. Chartered Engineers in most cases are not responsible for their designs beyond the final hand-over of projects. They are in the unenviable position of not getting experience of the operation of their design solutions. So, how can they be expected to improve?

It seems at each level in the Service and also in private practice, that much could be done to improve the existing situation. This is not implying criticism of those who are responsible for training. It must be remembered that the National Health Service is an extremely large organisation of which the engineers form a small part.

It is not in business to fulfil the aspirations of engineers, but to **provide a comprehensive Health Care Service for all people**, in which Engineering and Engineers have a part to play.

Therefore, it is important that those practical problems of combining theory (gained at Technician or Chartered level) are put together with the actual engineering practice. All engineers can contribute towards helping each other achieve these aims so that a closer relationship could develop between the designer on the one hand and the operation and maintenance engineer on the other. The rest of the paper is a brief attempt to show how this might be achieved in a period when economies in the Service are making it short of resources.

Possible Developments

Currently the emphasis is placed on academic qualifications, and these form the basic grounding for the theoretical training of Health Care Engineers. This training to a certain extent is that required by the whole gamut of the profession. The Health Service Engineering Function through the Whitley Council conditions of Service is built upon this practice.

This training is always external to the organisation and is provided by technical colleges or polytechnics. Technician Engineers have a further requirement and that is to take a management course. Apart from this formal situation, there is no other framework upon which Health Care Engineers can develop theory and practice together.

A firm proposal has been made to set up a National Staff Committee for Works Staff. This committee will have the responsibility to advise on the training needs of engineers. Due to lack of finance its future seems to be in difficulty. However, this development must be welcomed as a positive step in the right direction for all Works Staff.

A suggestion was made by Mr. John Bolton, then Chief Engineer and now Chief Works Officer of the DHSS,[2] that one possible way in which junior staff could be encouraged to take an interest in their development would be in the introduction of training log books. Using this method, training could be monitored and gaps identified. In addition, it would provide a useful record for the staff themselves. This idea has been tested before reorganisation with limited success in at least one Hospital Management Committee.[3]

The main problem seems to be the identification of the individual development needs of engineers, and then selecting these needs for further training. The wealth of post-entry training opportunities on specialist technical subjects must equal the facilities provided by any other public body. Health Care Engineers have excellent facilities for short specialist courses at the Hospital Engineering Centre at Falfield and at the Department of Environmental Training Centre at Cardington. These courses coupled with one-day seminars run by the DHSS and our own Institute provide a first class way of transmitting up-to-date information to those who require it. It is unfortunate that Health Care Engineers working in private practice do not have these facilities available to the same extent. This is an area in which in the future ties could be strengthened.

At this stage, it might assist the reader if a definition of management development was given:—

> 'Any attempt to improve the managerial and technical effectiveness through a planned and deliberate learning process.'

This process might be provided by various methods of training in which courses or planned experience could be examples.

A further difficulty giving rise to problems is the current practice of carrying out management training as an 'after-thought' subject, as one to be tacked on to a course at the end of a period of training. Now seems to be the appropriate time to consider changing the present system so that it may be integrated with the new technical qualification for Technician Engineers.[4] A better time is not likely to be found. At a more senior level, there are at least two British Universities that integrate management subjects with technical ones, already a practice which is on the increase.

The DHSS has already given provisional guidance[5] to the type of modules that would be suitable for Technician Engineers employed in Health Care Engineering. These modules are ideal in that engineers can now combine their academic studies usefully with their work. It is important that senior officers form close links with technical colleges to ensure that the right modules are always available. If these approaches are not made colleges will run courses to suit local industrial requirements alone. The colleges are there to fulfil local needs, and if the requirements of Health Care Engineering are not made known, then the academics will remain unaware of the problems and will not cater for this specialised subject.

In this respect it might be possible for Regional Engineers to play an active role. If links could be formed with certain colleges within a Region, then modules to suit Health Care Engineering could become available. This in turn might help our colleagues in private practice. This could be a way in which standards and even special modules could be arranged to suit Service needs. The South Bank Polytechnic has proved with its Environmental Engineering Courses that this approach can be successful. Once these links have been formed, the way would be open to develop future ties with Area and District Engineers. If any value is to be gained from academic and in-service training, engineers must be allowed to put into practice what they have learnt. The present problem is:—

> 'How best can this be done?'

From the first day that engineers join the Service they are in a management position, so it is most important that management and technical training should go hand in hand — a point recognised in the Tyler Report. The idea being developed in this paper, is that the best way in which this process might occur would be to allow engineers to carry out practical projects with varying types and degrees of responsibility.

If a visit is made to a local school or a week spent at Falfield, one finds the method of learning used to be that of Discovery Learning. This is simple in strategy but powerful in application. The proposition being suggested is to have a framework or model of development which embraces at the same time both academic and practical training. This would encompass managerial and technical training within an action taking situation.

The foregoing idea is not new to the Health Service. In fact, possibly its greatest advocate is Professor Reginald Revans. The core of his thinking is his belief that managers, as distinct from the tools of management and the subjects relevant to management, cannot be taught in the classroom. In his own words:—

> 'This particular design chosen emerges from the belief that managers like all other conscious creatures, learn to take effective action only by having taken effective action, and, by an awareness of their success in changing the actual management situation into which they are thrust.'

It is vital to be clear on this point. A man will learn in a classroom situation to talk about taking action, but in order to learn to take action he must take action and see the effect it has. The engineer, like his colleague the clinician, must provide his own personal integration of the diversified resources in his field. No matter how rich objective data may be; on its own it is never enough. The engineer must be aware of his responses to real situations. Indeed, the Medical Schools have already grasped this point — NO university has yet proposed to replace hospital beds and their patients by duplicated files of cases. Students must still make primary observations directly about the patients themselves and preferably while they are still alive in hope of salvation. Although Revans' ideas are not the only models of management development that can be used, they do seem to fit well, however, into the way that future Health Care Engineers could be developed and trained. Engineering should be a practical subject based upon sound scientific theory; so what better way could be evolved than to let both

Technician and Chartered Engineer develop by using individual expertise.

Other organisations do at the present time use alternative methods to achieve the same goal. The appraisal system, for example, appears popular in the Civil Service and with large industrial firms. In the Health Service both the National Staff Committee for Nurses and Midwives and the National Staff Committee for Administrative and Clerical Staff advocate this method. The basic system consists of getting the manager and subordinate together to appraise or talk about the latter's performance. It is thus assumed that the subordinate's effectiveness will be improved and any training opportunities identified. The major criticism of this method is that a subordinate is unlikely to divulge all his weaknesses and failings to a superior officer who controls future promotion.

It is strongly recommended that engineers do not fall into the same trap. It is normal for engineers to pull things apart to find out how they work. This approach when applied to people is negative. Therefore it is essential that a positive system is used — one that builds on strengths that can be self-directed at a pace set by the individual.

It has previously been suggested by Buckley[6] that Health Care Engineers should be encouraged to take responsibility for projects or units of work from initial concept through to completion. In this way managerial and technical skills would be allowed to develop and the consequences of decisions would be fully seen. This does not mean that there is no need for courses. They do have their place but it is important that they should be fully integrated to suit individual needs.

In the Health Service about 12,000 managers a year attend various management courses. As the worth of the courses is rarely evaluated, there is no feed-back on whether they do any good. So often the following words are heard after attendance at a course. 'It was a good course. I learnt a lot BUT it would not work here!'

There is no better way for engineers preventing themselves from being criticised than by demonstrating real organisational change. Objectives can be achieved by the use of this method. For this approach to be successful, it may mean that engineers have to organise their departments in a slightly different way. They would have to be constantly aware of the learning situation that arises every day. Delegation of authority would be important. The action learning technique can become a way of managing in its own right; it also copes very well with the problems of up-dating senior staff who may consider other forms of training inappropriate.

Conclusions and Summary

Although the foregoing is only a brief attempt to examine the situation now existing and offering a possible solution, it must be remembered that this is an age when engineers like other professional groups within the National Health Service are aware of the environment in which they are expected to work. They seek professional recognition from their colleagues in other faculties, personal job satisfaction and freedoms that would have seemed strange twenty years ago.

There is now a trend towards self-development rather than relying entirely upon the organisation and hoping that it will provide a framework in which to develop. This trend should be encouraged as has already been suggested in this paper. Engineers should be encouraged to take responsibility at a pace appropriate to themselves within a framework and career path determined by all engineers within the Service. Encouragement is especially required for Technician Engineers who can see little incentive to take on more responsibility. The erosion of pay differentials and the barriers to gain the necessary academic training to enable career progress to occur must be of concern to many at the present time.

The proposals in this paper do not solve these problems, but recognise that the development and training of each and every Health Care Engineer is unique. This applies not only to the individual but also to the section of the Service or Hospital in which he or she works, as the local culture and history of each establishment varies considerably. National solutions to development and training must take account of these factors. It seems fitting that the thought should now be given to:—

1. Integrating theoretical Technical and Managerial training;

2. Integrating theory and practice by applying it to real problems.

I believe that this could be achieved by the use of the 'Action Learning' technique. It is basically simple in concept and could easily be applied by engineers if they recognised that every single action taken by an engineer provides a real learning opportunity.

In practice Health Care Engineers could be exchanged, with their agreement, between Authorities with the advantage of mixing experience of design, operation and maintenance. A Hospital Engineer or a District Engineer could be seconded to a Regional Engineer's Department to work on various stages of individual projects thus providing a useful input of information and detail that would be self-rewarding when the project was handed over for operational use.

Other solutions could be used in pursuit of this goal, but the National Health Service Act's structure is unhelpful. It charges the various different Authorities, such as Regional and Area Health Authorities with differing responsibilities. The Health Care Engineer has to work within these constraints. Basically it is a local Service run by local people within a national framework.

And what of the Future?

If the Health Care Engineer wishes to progress towards senior Works Officer posts, he or she will have to have an understanding of the work of other professionals and a sound knowledge of how these professional groups operate. This experience could be best provided using the Action Learning approach. Engineers could be nominated to head design groups of differing professionals or vice-versa. The level of this activity could be determined by senior Works professionals at all levels.

Finally it should be stressed that whatever solution is proposed and adopted, it must be one that continues to unify ALL engineers within the National Health Service TODAY. Both Technician and Chartered Engineers must ensure that this is so. Their development and training must not be placed in water-tight compartments. No matter at what level they are employed they all require to gain practical experience.

Our own Institute of Hospital Engineering is doing much to bring about this unity. I would hope that it will continue in this direction in the future and that all health-care engineers may be brought together under the umbrella of one institute and that the institute may cater for the registration of its suitably qualified membership, both as technician engineers and chartered engineers.

I am sure that the unification of all engineers under the same excellent Institute may bring about the situation where members may describe themselves truly as professional engineers in health-care engineering.

In the final analysis it must be remembered that today's Health Care Engineer's main objective is, as it has always been, the contribution that he or she is able to make towards the care of the patient.

Useful Further Reading

Action Learning in Hospitals.* Revans, R. W.

Evaluation and Control of Training.* Hamblin, A. McGraw-Hill. 1974.

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A Discussion Document on Management Development.* Training Services Agency. January 1977.

***Highly recommended.**

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[1]**Report of the Study Group on the Work Grading, Training and Qualifications of Hospital Engineers.** Major General Sir Leslie Tyler. HMSO 1962.

[2]**Training of Health Service Engineers and Craftsmen.** John Bolton, Chief Engineer, Department of Health and Social Security. Hospital Development. June 1974.

[3]**Assistant Engineers' Training Scheme.** Engineers and Assistants of South West London Hospital Management Committee. 1974 (unpublished).

[4]**A Guide to Current Developments in Technician Education for the Works Profession. Parts I and II.** *Hospital Engineering.* November and December 1977.

[5]**Chief Engineer's Letter, DHSS.** CE(77) 17 DHSS. September 1977.

[6]**Management Development — The Way Ahead.** R. D. Buckley. International Federation Issue No. 20 — *Hospital Engineering.* November 1976.

This paper was presented at the Institute's 34th Annual Conference in Cardiff earlier this year. The paper was written by Paul Tyler of Austen Associates, Consulting Engineers, in association with Paul James of Hospital Design Partnership, Architects.

Engineering Building Services for Nucleus Hospitals

P. A. TYLER FINucE FIHospE MAshrae MRSH

W. P. JAMES RIBA DipArch

Architecture

There are numerous applications of Nucleus under active consideration throughout the UK and some of these are in the planning and design stages. For the purposes of this paper, the authors have selected three schemes which appear to be the front runners at the moment, and on which one or other of them is engaged.

The three hospital projects discussed in this paper are all in the Thames regions. They are:

Redhill

South West Thames RHA (due on site Autumn 1978 — tenders completed)

Architect: Hospital Design Partnership

M and E: Austen Associates

Structural Engineers: Ove Arup

QS: Walchli & Wilkins in association with RHA chief works officer, architect and engineer.

Newham

North East Thames RHA (due on site April 1979 — production drawings in progress. Piling is almost complete for foundations. Roads and drainage contract out to tender)

Architect: Hospital Design Partnership

M and E: Roger Preston & Partners

Structural Engineer: Clarke Nicholls & Marcell

QS: Walchli & Wilkins in association with RHA chief works officer, architect and engineer.

Maidstone

South East Thames RHA (pre-phase. 1979 — due on site 1980)

Architect: Powell, Moya & Partners

M and E: Austen Associates

Structural Engineer: Charles Weiss

QS: DHSS/Axtell, Yates in association with RHA chief works officer, architect and engineer.

Background

'Nucleus' comes to terms with the prospect of a reduced level of capital investment for some time to come. It provides for a strictly limited content (300 beds) within a work cost below £6 million. (*Capricode* cost limits at May 1975) as a first phase of a hospital which could grow and change up to 600-900 beds. Like 'Best Buy' it is a mainly two-storey concept with compact functional relationships and with emphasis on multi-use of space, natural light and ventilation and economic structures.

Like the previous DHSS development projects — 'Best Buy', 'Harness' — 'Nucleus' has one main objective: to provide systematic briefing based on standard policies and plans in order to eliminate the need for 'one-off' solutions. Two projects of similar size and complexity, one using a traditional 'one-off' approach, the other utilising 'Harness'/'Nucleus' briefing show considerable savings on time and cost in the latter case.

Nucleus Solutions at Redhill, Newham and Maidstone

The content of each Nucleus first phase will reflect the service priority needs of the district in which it is to be built.

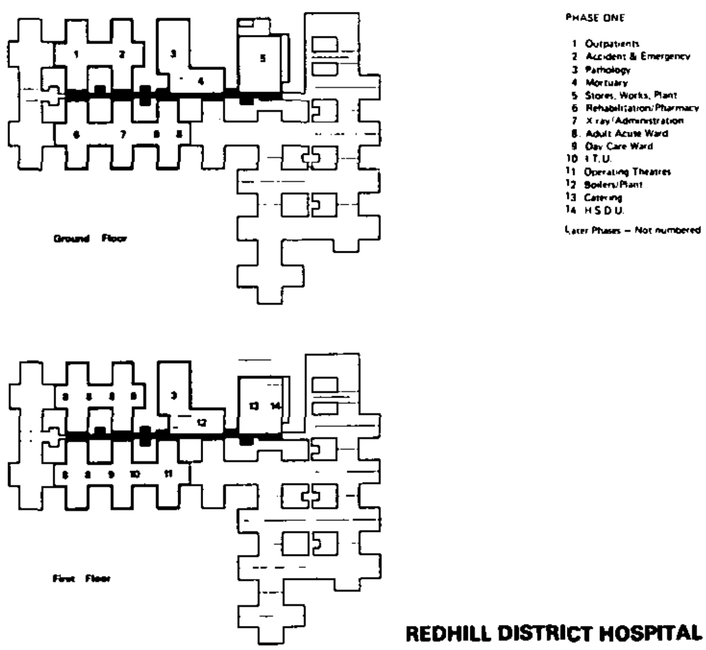
Figure 1 compares the functional content of the three projects. Note that substantial variations occur in all three functional zones — in-patient, clinical and supporting services.

The development control plans for each project are illustrated in *Figures 2, 3* and *4*.

Figure 1. Comparative Functional Content

DEPARTMENT	NEWHAM	REDHILL	MAIDSTONE
In-Patients			
General Acute Wards	224 beds	224 beds	112 beds
Children's Wards	69 beds	Nil	46
Obstetric Wards	Nil	Nil	75
Geriatric Wards	Nil	Nil	25
ITU/Coronary Care	8 beds	8 beds	8 beds
Total	301 beds	232 beds	266 beds
Clinical Sciences			
Operating Theatres	4 theatres	4 theatres	4 theatres
X-Ray Department	4 rooms	4 rooms	4 rooms
Pathology	20 LSU's	41 LSU's	20 LSU's
Rehabilitation	200,000 population	200,000 population	500 m²
Out-Patients	67½ sessions	67½ sessions	81 sessions
Accident and Emergency	110 patients	110 patients	110 patients
Supporting Services			
Kitchen	600 meals	600 meals	600 meals
Dining Room	300 meals	300 meals	300 meals
Stores	300 beds	300 beds	Off site
Boiler House	HW 2,040 kW/St 1,556 kW	3,544 kW	2,700 kW
Works Department	300 beds	300 beds	Off site

Figure 2.
Adult Acute Ward
REDHILL DISTRICT HOSPITAL



Floor Plans
REDHILL DISTRICT HOSPITAL

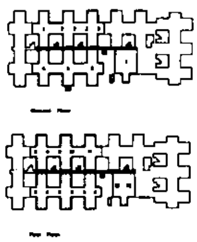
Redhill

(*Figure 2*) is sited within a large unrestricted site in the grounds of the Royal Earlswood Hospital. There is direct and easy access from a trunk road to the principal entrances for people and goods. Ample site is available for future phases. A two-storey solution provides wards and theatres on first floor, and out-patients, X-ray, rehabilitation and some wards on ground floor, all in standard department 'templates'. Non-standard accommodation includes large area pathology department, mortuary, and central boiler house on first floor. There is an 'L'-shaped street with supplies block in 'corner' together with service lift and ramp for movement of supplies.

Newham

(*Figure 3*) is sited over a gravel pit in north-east London bounded by Gas Board mains and main outfall sewer lines. First phase is located in the north-west corner on approximately 4.5 hectares; future phases are planned to the north-east. Newham is an orthodox, two-storey solution with adult acute wards and theatres on first floor,

Figure 3. Newham District Hospital.



PHASE ONE
1, Rehabilitation/Pharmacy; 2, Children's Ward; 3, Pathology; 4, Outpatients; 5, Accident and Emergency; 6, X-ray/Administration; 7, Stores/Works/Mortuary; 8, Adult Acute Ward; 9, Day Care Ward; 10, ITU; 11, Operating Theatres; 12, HSDU; 13, Catering.
Later Phases — Not numbered.

and out-patients, A and E department, X-ray and rehabilitation on ground floor, all contained in standard cruciform templates. A two-storey services block provides catering, sterilising, central stores, works and maintenance departments to serve the first phase designed for expansion to meet the needs of future phases. De-centralised boiler houses and plant rooms are provided on the roof of the linear street.

Maidstone

(*Figure 4*). The site is part of the grounds of a large mental hospital — Oakwood Park. Ample site area is available for remaining phases. The development control plan follows the L-shaped street arrangement similar to that of Redhill. However, the main entrance is sited at the angle of the L, adjacent to the services complex and not at the 'growth' end as at Newham and Redhill. The layout demonstrates the flexibility of Nucleus with the introduction of a standard 75-bed obstetric unit on the first floor in place of some of the adult acute ward units.

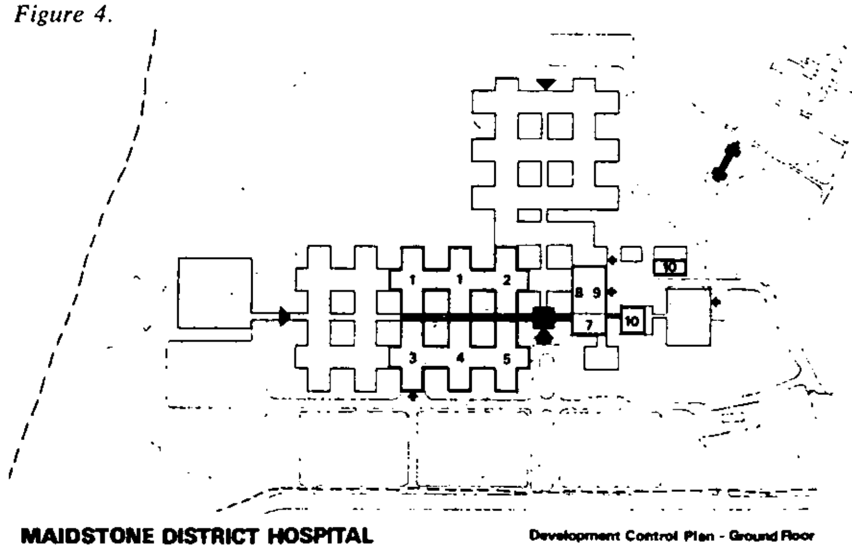
Building Design

Unlike Harness and Best Buy, Nucleus architectural data excludes final design and production drawings. Therefore this work is done at project level and this arrangement does allow for considerable variation in the design and selection of building components.

Figures 5 and *6* compare the typical cross sections of the three projects. Note the differing roof shapes, structural frames and external cladding systems. Note the vertical dimensions.

They also compare the variations to the typical sections in each scheme to allow for the servicing requirements.

Figure 4.



1, Children's; 2, Outpatients; 3, Accident and Emergency; 4, X-ray/Administration; 5, Rehabilitation/Pharmacy; 6, Entrance; 7, Pathology; 8, HSDU; 9, Stores/Works/Mortuary; 10, Services.

Figure 5.

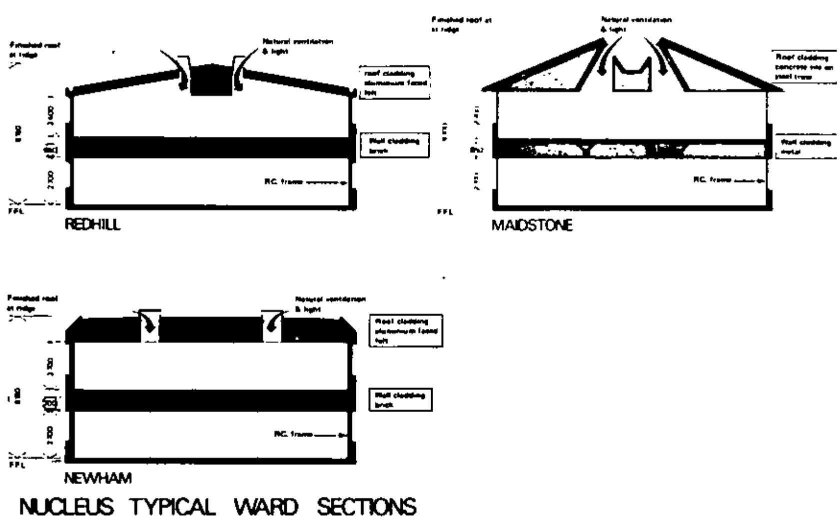
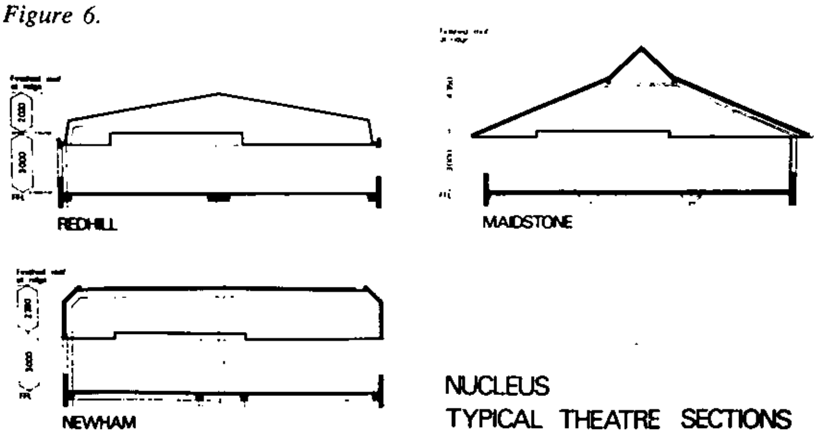


Figure 6.



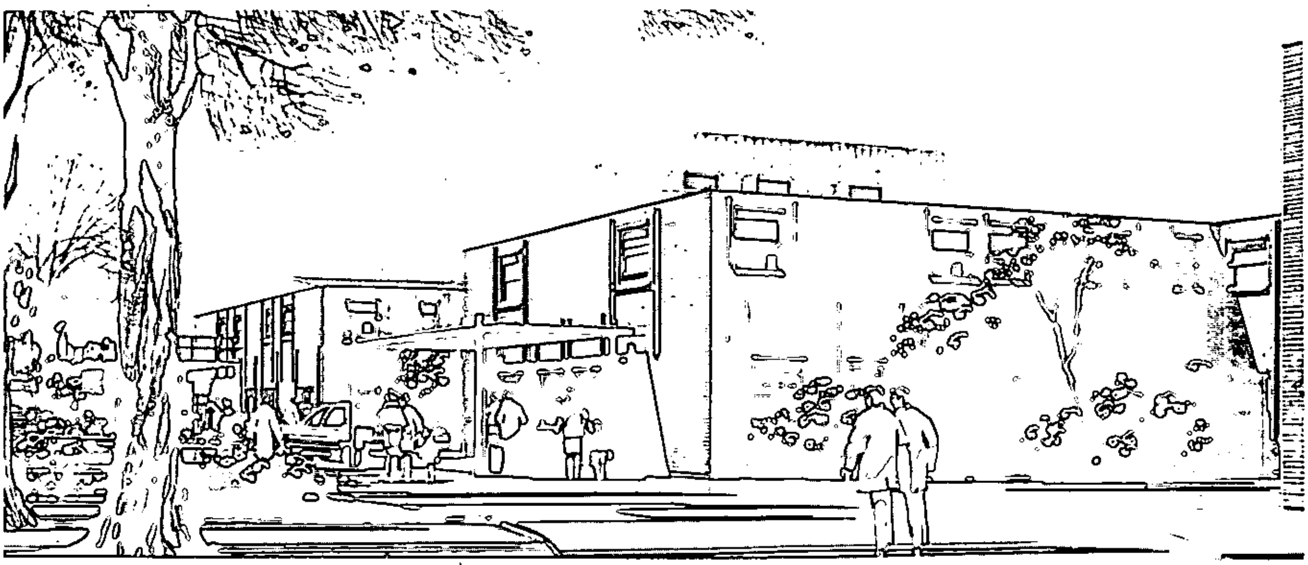
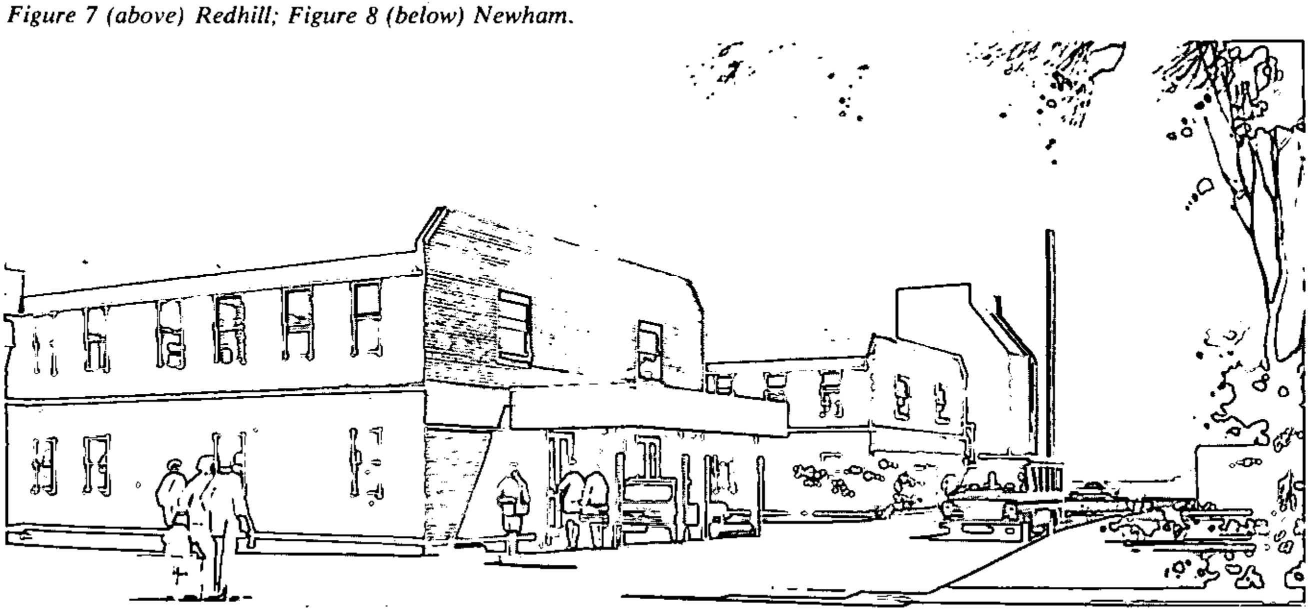


Figure 7 (above) Redhill; Figure 8 (below) Newham.



Environment

The two-storey, compact, landscaped courtyard development should blend into, not dominate, its environment.

The front cover illustration and *Figures 7* and *8* show external views of the three projects. Maidstone and Redhill seem to present a softer appearance with their pitched roofs appropriate to their parkland setting. Newham is set in a treeless industrial area of north-east London.

Engineering Building Services

This part of the paper examines the application of Nucleus Health Building System Engineering to three District General Hospitals currently commissioned to nominated private design teams.

For Maidstone and Redhill District General Hospitals, Austen Associates are the consulting engineers. For Newham, J. Roger Preston are the consulting engineers, and I am indebted to Derek Thornley and his team for their valuable contribution.

Nucleus Health Building System Engineering

Let us first examine the design start time influences which have played an important part in the engineering design philosophy evolved for the three hospitals. As will subsequently become apparent there are significant differences in approach. In the case of Redhill particularly, the time relationship between full availability of Nucleus data and commencement of design of the scheme is a dominant factor. A decision was taken therefore, at the beginning of the design process, to proceed on a virtually 'one-off' basis. Nucleus engineering principles would be incorporated as they became fully defined, so long as this would not be detrimental to the overall programme. It is perhaps pertinent to mention that the flexibility of the Nucleus approach has, to a very large extent, permitted development of the engineering designs concurrent with production of the final data, without undue penalty. It has also been possible in many instances to incorporate refinements in Nucleus data as they have been identified by the Nucleus engineering team. Consequently the basic fabric of Nucleus principles are maintained in the engineering designs for each hospital.

For those who are not fully familiar with Nucleus engineering principles, I will briefly outline them as follows:

Engineering briefs and policy are laid down in Volume No 3 of *Health Building System Engineering.* Zoning and Spacing Rules are covered by Volume No 4C. These two packs form the basic data on which individual departmental data packs hang, and provide guidance rules for designing the engineering services for a Nucleus hospital. Volume No 3 incorporates design briefs for all the hospital services as follows:

Water Services — Hot and Cold;
Heating and Cooling;
Ventilation;
Medical Gases;
Industrial Gases and Fuels;
Electrical;
Battery Services;
Communications — Telephones and Local Intercom, Clocks, Patient Radio and TV, Patient/Nurse Call System, Alarm Signals, Staff Location;
Protection Systems — Anti-Static Precautions, Lightning Protection;
Lifts and Hoists;
Drainage;
Fire Precautions;
Insulation;
Supports;
Controls.

The foregoing briefs are sub-divided into five main headings as follows:
(i) Whole Hospital Considerations, including incoming main services;
(ii) Departmental Considerations;
(iii) Hospital Street Considerations;
(iv) Service Centre;
(v) Design Standards.

This data provides the design engineer a basic brief for a standard solution, which by integrating any particular requirements enables him to determine his full brief without the normal recourse to evaluation of a range of alternative solutions. From this will be apparent the intentions of Nucleus originators to identify that large proportion of design data common to all hospitals, whilst at the same time permitting sufficient flexibility necessary to meet individual needs.

Figure 9 shows the central services services solutions arrived at by the Nucleus team for a standard hospital, and indicates plant room relationships. Plant Room No 2 houses two LPHW boilers which serve LPHW to a perimeter radiator/convector circuit, weather compensated with 'trimming' thermostatic valves. The boilers also feed via two constant temperature circuits, hot water service calorifiers and air heaters, unit heaters, and fan convectors. Recent refinement of Nucleus hot water service policy indicates this may change to load levellers for the Departments housed in Plant Room No 2, and Angelerys for the Service Centre housed in Plant Room No 5.

Cold water is provided in potable and non-potable concrete tanks located at Plant Room No 5 — this being a variation on previous storage policy of localised tanks in Plant Rooms 1, 2, 3, 4 and 5.

For the Service Centre and humidification demands two steam boilers are located at Plant Room No 5. Plant Room No 5 also houses one incinerator, HWS Calorifiers/Generators, and ventilation plant for the Service Centre.

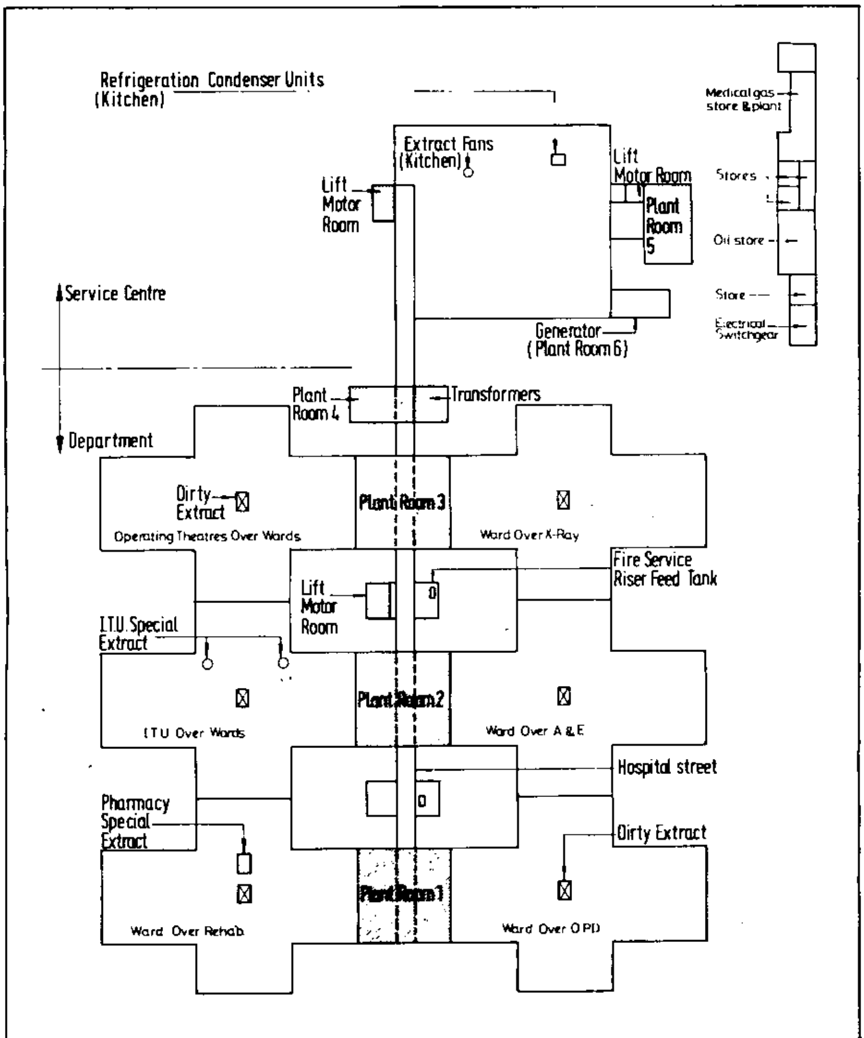
Fuels recommended under Nucleus policy, to fire the boiler plant, are guaranteed supply gas, or 35 secs. fuel oil where gas is not available.

Plant Room No 4 houses vacuum plant, chilled water units and cooling towers; Plant Room No 1 houses supply, clean extract and smoke extract plant; No 2 supply, clean extract and smoke extract plant, and LPHW boilers.

Dirty and special extract are generally catered for by roof fans sited away from the street plant room air intakes.

Telephone exchange and frame room are accommodated in the Service Centre, as is the MV switch room and transformers, which are laid against the street in the Plant Room 4 location. The HV switch room is accommodated in an adjacent compound together with medical gases. The standby generator is situated at

Figure 9.



NUCLEUS HOSPITAL
PLANTROOM LOCATION PLAN

the Service Centre. Pathology gases, where this department is provided, are contained within the department, or otherwise separated from the main hospital gases.

At each pair of interfaces at ground floor level a switch room is provided containing essential and non-essential switchboards. There are also switch rooms at first floor level to isolate first floor departments in the event of fire. From these switch rooms essential and non-essential sub-main cables run to departmental switch cupboards.

Finally, on the subject of engineering briefs, reference must be made to the individual data packs which further supplement Volumes 3 and 4 by providing load schedules, design description, and worked examples of services designs for standard departments. It should be noted that each department cluster comprises a non-extendable cruciform made up of four modules, three whole and two halves. Any extension required is dealt with by 'plugging-in' a further cruciform to the street, and in this way the effect of extensions on services distribution is confined to the street.

Distribution in heavily serviced buildings requires careful evaluation, and the Zoning and Spacing Rules defined in Volume 4C are intended to minimise installation problems. Briefly, the Zoning and Spacing Rules identify routes and zones at which all services can run within a Nucleus structure. The distribution zones available are ceiling voids at Ground and First Floor level in the streets, and within the department ground floor ceiling and first floor roof. All central services emanate from either plant rooms adjacent to the service centre, or plant rooms at roof level sited along the hospital street. In this manner the street becomes an 'artery' into which the departmental 'veins' are connected. At the department interface with the street, vertical distribution ducts permit services to be distributed from either of the two street voids to the required departmental horizontal distribution voids. As will be seen, this distribution network dictates a 'down feed' terminal distribution system, which is accommodated by vertical wall voids at the building perimeter. This distribution system also allows each floor of the hospital to be served and isolated independently.

Finally, I must make it clear that the foregoing outline is intended only to illustrate the basic principles, and I do hope I will not be taken to task too severely by any of the engineers from the Nucleus team should I have failed in any way to paint a reasonable picture.

Nucleus Applications

Let us now pass on to Nucleus applications to three sites.

I intend to concentrate only on those constraints, influences, or individual problems which have combined to determine design philosophy for each of the three hospitals, and which have dictated departures from standard Nucleus engineering. I shall commence with site influences, proceed to site and central services, then to whole hospital considerations, and finally services within the building.

Site Influences

The Redhill District General Hospital will be situated adjacent to Royal Earlswood Hospital, but not in such close proximity as to permit energy sources at Earlswood to be extended to Redhill. No site influences apply therefore.

Newham is a similar case, is on a virgin site, and has therefore been considered independent of external factors.

Maidstone will be sited next to Oakwood Hospital, in very close proximity, and to a degree primary considerations for Maidstone must logically therefore be evaluated in the light of this large energy consumer, which has a patient population of about 1,300. The current prediction is that the energy demand of this hospital will remain, and possibly increase due to future upgrading, for the life of the new Maidstone District General Hospital, which has a sixty-year design life. The present boiler plant at Oakwood requires attention, and the Electricity Board require rationalisation of their supply on the basis of Oakwood and Maidstone being classified a single consumer.

Main Services

At Redhill there are no outstanding features related to incoming services. Some measure of reinforcement to the water supply will be carried out to local supplies over common land, enabling a two directional supply to be provided to the hospital, the cost of which will generally be met by the Water Authority. Sufficient medium pressure gas is available on a guaranteed supply basis, and in this instance three weeks' gas oil will be provided as standby fuel to the boiler plant. An 11 kV electrical supply will supply the first phase hospital. GPO telephone lines to the site will connect to a PABX3 installation.

Newham is similarly accommodated by mains services, and as far as I am aware there are no notable aspects worthy of identification.

Maidstone can obtain adequate gas and electricity supplies, but the water supply network in the area is poor, and requires extensive reinforcement to supply the new District General Hospital. To minimise contribution costs, and to ensure guarantee of supply, it has been decided to provide on-site ground level storage coupled with a Fire Brigade static reserve requirement. Transfer and fire booster pumps can be linked to the essential electrical supply, so that the hospital is rendered less vulnerable to pressure fluctuations in the Water Board mains or breakdown of their pumps. Additionally the storage 'buffer' will enable a smaller supply main to be run to the site. A ten-inch medium pressure gas main crossing the site will require diversion. However, the cost of this diversion will be largely borne by the Gas Board in return for the Region's acceptance of an interruptible gas supply offer to fire replacement burners on the Oakwood boiler plant, currently fired on heavy fuel oil. This reburnering and diversion work is being executed this year.

The benefit to Maidstone is twofold, in that a heavy capital expenditure is avoided on diversion work and, additionally, an extension of the cheaper interruptible gas supply tariff has been negotiated for the new District General Hospital as an extension to the Oakwood contract. The respective cost of the two gas tariffs is 16.5p and 13.5p on current prices.

Rationalisation of the electrical supply will be achieved by establishment of a switching station adjacent to the new Maidstone District General Hospital, feeding both Maidstone and Oakwood.

The next consideration is boiler plant and central services.

Newham adopts standard Nucleus policy of rooftop LPHW boilers fired by guaranteed supply gas burners. Steam boilers at Plant Room 5 are similarly fired. Cold water is stored in sectional steel tanks in Plant Room No 5. Hot water is provided by three load levellers serving the whole Phase 1 hospital sited at Plant Room No 5.

The water softening plant has been sited in the ancillary buildings. In all other respects I believe that standard

Nucleus guidelines have been successfully applied and adhered to. The notable exception concerns distribution of natural gas and steam and condensate which are routed overroof. This deviation from neutral Nucleus must be attributed to the ever-increasing standards imposed by health and safety requirements.

Redhill departs from neutral Nucleus by virtue of the 'one-off' nature of the design approach resulting from its start well before the other two hospitals, and it is in the area of central services that the departure is most pronounced. Central services emanate from a plant complex of four levels sited alongside Pathology. Level 1 houses an incinerator and refuse area, chilled water plant, medical compressed air and vacuum plant, medical gas manifold rooms and bottle storage. This area also houses the main electrical intake, transformers and the medium voltage switchgear. The standby generator set is situated at the rear of the Service Centre. Level 2 houses the steam boilers, a waste heat boiler, LPHW calorifiers, and hot water storage calorifiers; additionally the ventilation plant serving the very large Pathology Department and Mortuary. Level 3 houses the supply air plant for the departments and the ventilation plant for the Operating Theatres. Level 4 houses sectional steel cold water storage tanks and feed and expansion tanks. Ventilation plant for the Service Wing is housed in a separate roof level plant room above the street adjacent to the Service Wing.

The local plant rooms along the street house local clean and dirty extract and smoke exhaust systems.

Maidstone tries to adhere strictly to Nucleus policy, as it is the latest of the three hospitals we are discussing. Every departure has been evaluated on a 'present worth' basis, and a design team decision has then been made as to whether or not to accept whatever technical and cost benefit or penalty may have been identified.

The Oakwood steam raising boilers have a remaining useful life of about ten years, but the heavy oil low pressure air burners are obsolete. As a result a decision has been made to re-equip with dual-fuel burners in the current year, taking advantage of a favourable gas tariff, and overcoming a severe smutting problem associated with the present chimney.

When the useful life of the boilers is at an end, a policy decision will be taken on possible centralisation of heat generation at Maidstone. For this reason the small cost penalty of providing a steam-raising central boiler house at Maidstone has been accepted. This boiler house is contained within a central services area which also contains the electric sub-station, cold water storage, hot water generators for the Service Centre, incineration, medical gas equipment, water chillers, cooling towers, and water treatment plant. In an adjacent area the standby generator, oil storage, domestic and fire water storage, and hazardous gases will be accommodated. All of these plant areas have been so arranged as to permit extension to meet future development at Maidstone, or deal with boiler plant centralised from Oakwood. Additionally the oil burners installed on the Oakwood boilers will be adaptable for heavy fuel oil should future fuel policy dictate the use of this fuel.

It is also conceivable that solid fuel could be used at Maidstone if scarcity or cost of liquid or gaseous fuels enforced its adoption in the future. The nature of the planning at least does not wholly preclude this option.

The remainder of central services policy will reflect Nucleus solutions, with the exception that in Plant Room No 2, steam/LPHW calorifiers will replace LPHW boilers.

The next area we wish to discuss is that of whole hospital considerations for an ultimate development up to an 800-bed District General Hospital.

Nucleus strategy attempts as far as possible to service a first phase hospital without penalty of further phase influences either in cost, or disruption of services when subsequent phases are built. This is implemented by the modular approach to plant provision whereby rooftop modules are attached to each cruciform, or collection of cruciforms.

For structural or other reasons cold water storage does seem to gravitate to central storage at Plant Room 5, although it is optional for individual design teams to adopt a decentralised solution. As to electrical supply this is catered for by allowing space for additional cables to be run down the streets for a notional allowance of an additional two or four two-storey cruciforms.

Newham strictly obeys Nucleus whole hospital engineering strategy, as there are no influencing factors to warrant consideration of alternatives, either by nature of the siting, or Regional policies. This is a good example of a neutral Nucleus engineering solution applied to an independent site.

Redhill varies Nucleus engineering primarily by the adoption of a centralised strategy into which the possibility of extending the heat sources has been built, to cater for the anticipated ultimate development. Alternatively, the second wing, extending the hospital up to its ultimate of 800 beds, can be catered for by modular plant areas complying with Nucleus policy.

Maidstone strategy is similar to Redhill in that a first phase central plant area will cater for ultimate development of the first phase wing, with a second area established to deal with the second wing. Future phase heat generation would be concentrated at the first phase plant area by extension of the steam-raising boiler house as required.

Facilities — eg oil storage and generators, common to both plant areas of the whole hospital, have been positioned relative to the demand points. Similarly the heat generation source is at the centre of gravity of the Maidstone / Oakwood potential demand points.

Waste Disposal

Newham and Maidstone follow standard Nucleus policy of providing a single incinerator. However, studies we have carried out do indicate there may be a case for waste heat recovery plant where we encounter a situation of close proximity as at Maidstone and Oakwood, and further research into such situations may well be beneficial.

At Redhill a waste heat recovery policy has been adopted, and the designs incorporate one steam-raising boiler served by a waste heat incinerator, functioning on the principle of recovery of its flue gas waste heat within the steam-raising boiler. This incinerator is capable of dealing with all waste except bottles or kitchen waste. Kitchen waste for all the three hospitals is dealt with by maceration. Bottles are taken away by the Local Authority. The planning of the Maidstone plant area would permit the inclusion of waste heat boilers at a future date by extension of the incineration area.

Heat recovery for Nucleus hospitals has been the subject of an engineering study report prepared in May 1976. This report appears to deal with departmental air handling only, and concludes that the simplest and most economic method of recovering heat from exhaust air was by recirculation, where this is permissible. As a consequence, heat recovery equipment has only been incorporated into Redhill. At Maidstone it is hoped to allow sufficient space in the air handling plant rooms for addition of heat recovery plant if future economic studies so influence.

At Redhill the Kitchen exhaust has been provided with a plate type heat exchanger to heat the fresh make-up air supply, as studies indicated this to be economically viable. Similarly, a study on the recovery potential on heat rejected from the chillers for Redhill indicated an economic recovery application, and therefore a heat recovery condenser has been incorporated which is used to pre-heat the HWS feed tank. As the 'at-risk' patient accommodation at Redhill is minimal in terms of limitation of hot water supply temperature, the storage temperature has been set at the conventional 60/65°C. In future phases as and when 'at-risk' patient areas are added a second 44°C circuit could be added by using the pre-heated water suitably topped up as required by a hot water generator.

Fire policy for the three hospitals broadly follows that established by national Nucleus fire policy. An interesting deviation is at Newham where a dry riser fire main has been incorporated, due presumably to local brigade requirements.

Safety aspects are in a progressive state of flux as the requirements of the Health and Safety at Work Act become more defined, and refined. I understand that the DHSS are in negotiation with the Executive in an attempt to establish a national policy for Nucleus. If this is achieved it will clarify many issues which are currently potential pitfalls for the designer. An interesting recent development in this respect concerns planning relationships, for flammable gases and fuels which have been advised by the regional officers of the Executive dealing with Redhill.

These relationships are shown in *Figure 10*, and their planning consequences will be obvious. A further problem arises on the installation of oxygen lines. The current acceptable requirements appear to be to run oxygen lines in a free air situation wherever possible, or within ventilated voids.

Services within the departments of the three hospitals all follow Nucleus engineering principles.

The exception is Redhill where the one significant deviation, caused by the roof solution, dictated that the first floor heating circuit be positioned in the ground-floor ceiling void feeding upward to the radiators above. The roof structural solution also dictated that the roof services void be confined to the centre of the cruciform. An additional deviation is centralisation of the department core supply air plant at the central plant complex. *Figure 5* shows the typical ward roof solutions for each hospital, all of which are different. However, these have been dictated by structural or architectural considerations and have not affected application of the zoning and spacing rules, with the exception of Redhill which I have just explained.

Figure 6 shows the distribution voids for the operating theatres in each hospital, all of which are housed on the first floor. Again, each solution for the heavily serviced roof voids is different, as one would expect, since one must consider the visual relationship with the roofs of the other departments. By the very nature of servicing influences associated with operating theatres and similar heavily serviced departments these are generally established at first floor level, and wherever possible in close proximity to energy sources. It will be seen that one distinct advantage of the modular Nucleus solution to plant provision, is that it allows a rather more flexible approach to positioning of heavily serviced departments along the hospital street, in respect of cost penalty on distribution mains where such departments are remote from centralised services.

Figure 11.

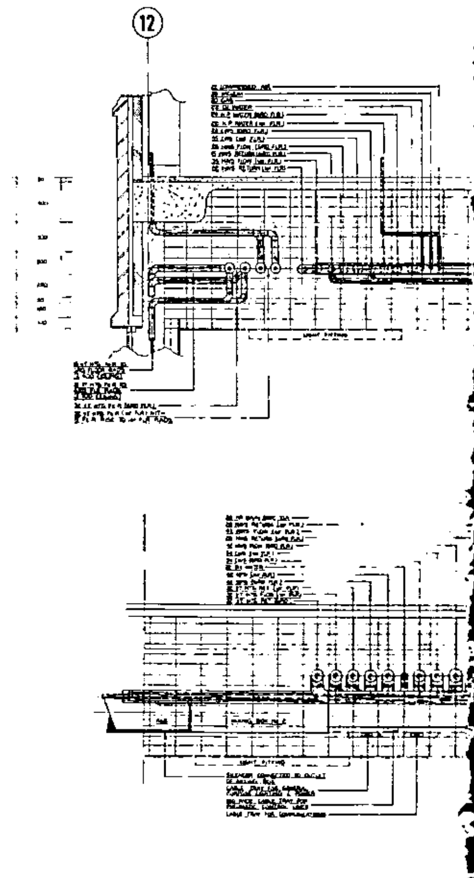
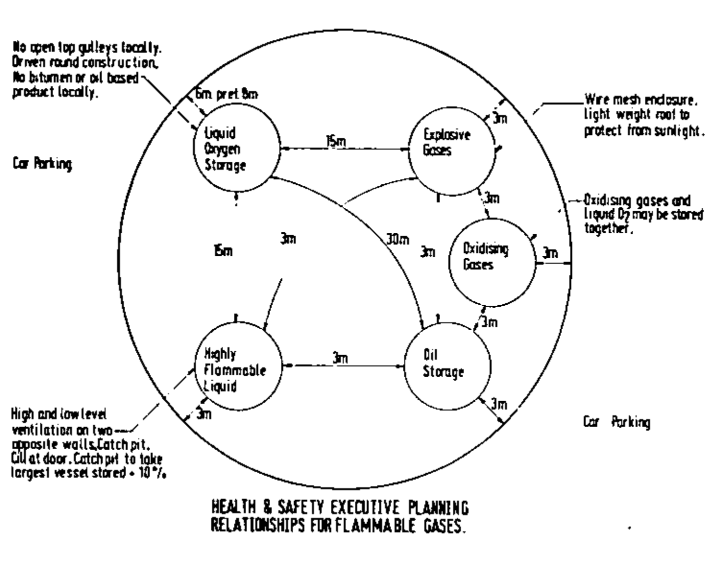


Figure 10.



Ward Ventilation

Studies carried out by J. Roger Preston and ourselves indicate that discomfort could occur in first floor ward areas under certain summer conditions, due primarily to the heat gain through the roof. Consequently on both Redhill and Newham ventilated roof lights are intended to be provided in order to mitigate this situation. A similar provision is proposed for Maidstone.

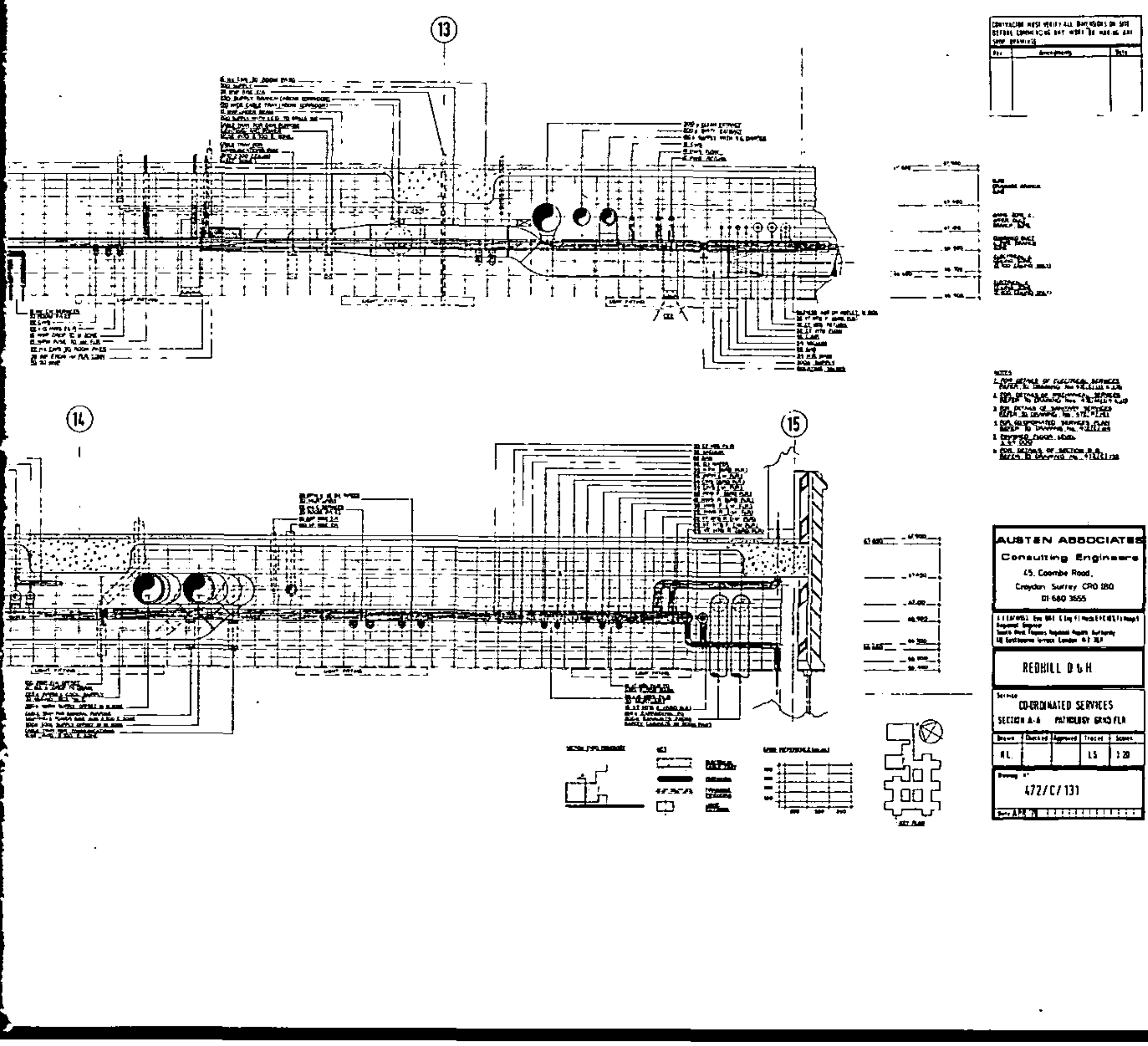
With regard to lifts, I understand that Nucleus provision caters for two bed/passenger lifts laid against the hospital street, and one goods/passenger lift at the Service Centre. In the case of Newham and Maidstone this provision has been increased by one bed/passenger lift, for operational reasons brought about by a variation in department relationship to that of neutral Nucleus. At Redhill three bed/passenger lifts will be provided, plus one goods/passenger lift at the Service Centre, and a further goods/passenger lift and a hoist for the exceptionally large Pathology Department. The Maidstone Pathology Department is smaller, with hoist only.

Studies carried out by ourselves and J. Roger Preston concluded that the Direct Acting Hydraulic Drive form of traction is to be recommended, and this has been implemented for all three hospitals. Nucleus policy on lift traction appears to be neutral and left to the discretion of individual design teams and Regional policy influences.

Time precludes extensive examination of the thermal envelope of the three hospitals, and I will confine myself therefore to mentioning that standard Nucleus heat energy consuming installations are all based on a thermal envelope performance optimised by an engineering study carried out by the DHSS. In essence the thermal values arrived at relate to the 1972 Building Regulations, the second Amendment dated 1974, and the third amendment dated 1975. These values are incorporated into the engineering briefs, as is the permissible external wall glazing area percentage. All three hospitals incorporate this standard of thermal value, and due account has been taken of condensation risks in humidified areas.

Co-ordination is a key-note of Nucleus engineering principles. All heavily serviced buildings can suffer from poorly co-ordinated designs, and it is significant that this is recognised by the Supplementary Annexure recently agreed with the DHSS for extension of Consulting Engineers' services for preparation of fully co-ordinated drawings (one of these prepared for Redhill is shown in *Figure 11*).

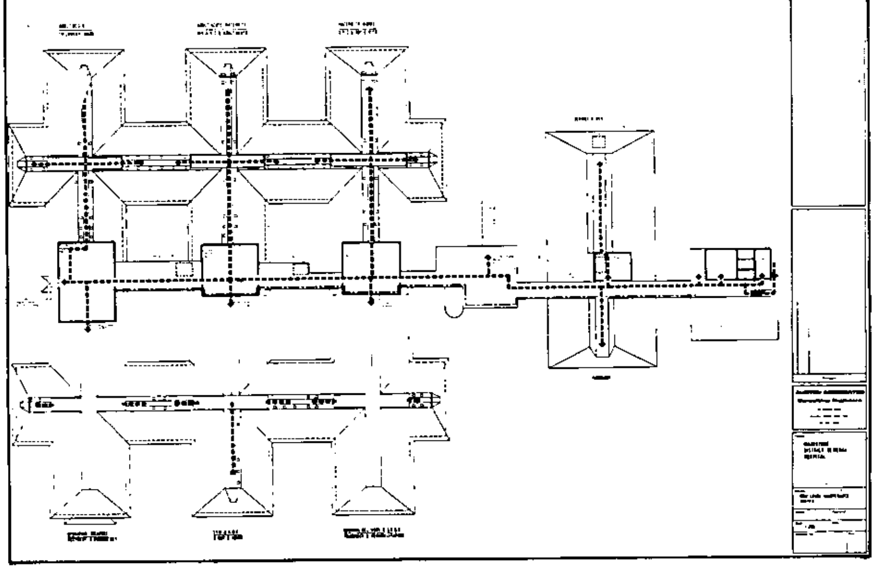
Finally, I would like to mention maintenance, which I am sure is a matter very close to all hospital engineers' hearts. It did occur to me that you would all wish to know that



this vitally important factor is at the forefront of design team thinking for each of these hospitals. *Figure 12* shows the maintenance and access routes typical for the hospitals, most of which are overroof in accordance with Nucleus policy. Within the departments all maintainable items, again in accordance with Nucleus policy, are placed, wherever possible, in areas where least disturbance is caused to operational departments. Access to ceiling voids is from below.

In conclusion, Paul James and I wish to acknowledge the valuable assistance rendered by the DHSS architects and engineers, officers of the South East, North East, and South West Thames Regional Health Authorities, Powell, Moya & Partners, and J. Roger Preston & Partners, without which compiling this paper would have been rendered infinitely more difficult.

Figure 12.



This paper was presented at the Institute's annual conference in Cardiff earlier this year. Mr Gibbons is Regional Steriliser Engineer at Trent RHA.

Steam Sterilisers

S. A. GIBBONS BA CEng MIMechE MCIBS FIPlantE

In the hospitals of the United Kingdom, moist heat is the medium used for sterilising the majority of items which have to be re-cycled. Like any other sterilising process, its efficacy is related to the initial level of microbial contamination of the goods to be sterilised; the lower the contamination the greater the margin of safety. The parameters for moist heat sterilisation are the time at temperature relations as stated by the British Medical Council[1] and in the European Pharmacopœia.[2] These are given in *Figure 1*.

These time/temperature relationships may be considered to have an exponential relationship and when extrapolated at both ends gives a curve as shown in *Figure 2*. If a base of log time is used the straight line graph of *Figure 3* is obtained. From *Figure 2* it can be deduced that with

Figure 1.

Time at Temperature Relationship (Moist Heat)

Temperature	Minimum Time	
$134 {}^{+4}_{-0}$ °C	3 minutes	MRC
$126 {}^{+3}_{-0}$ °C	10 minutes	MRC
$121 {}^{+2}_{-0}$ °C	15 minutes	MRC
$115 {}^{+1}_{-0}$ °C	30 minutes	EP

Figure 2.

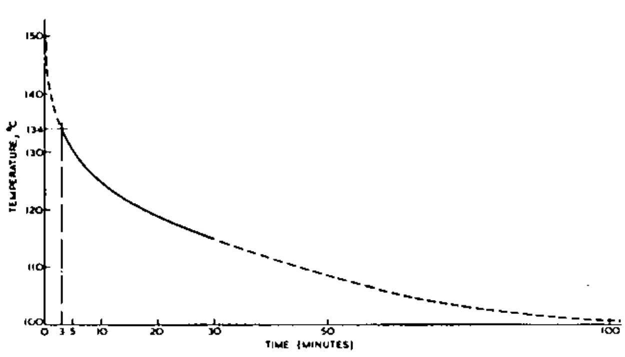


Figure 3.

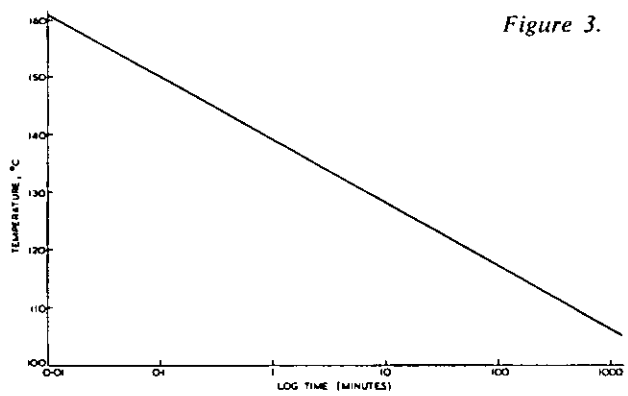
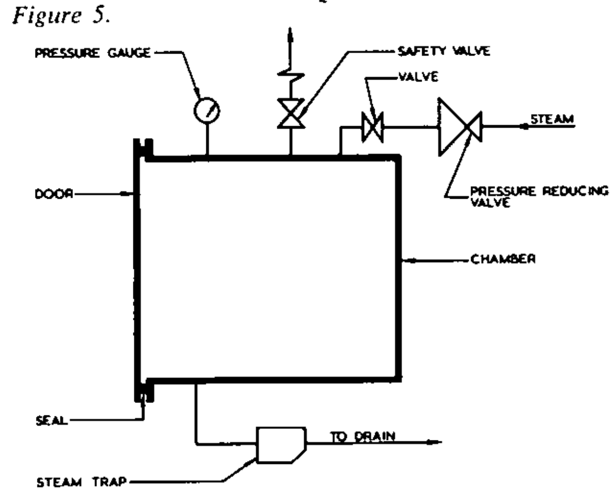


Figure 4.

Temperature	Minimum Time	Pressure (Dry saturated steam)
134^{+4}_{-0} °C	3 minutes	206.84 k Pa
126^{+3}_{-0} °C	10 minutes	137.90 k Pa
121^{+2}_{-0} °C	15 minutes	103.42 k Pa
115^{+1}_{-0} °C	30 minutes	68.95 k Pa

Figure 5.



extrapolation to infinite time, the corresponding temperature would be slightly greater than 100°C. Thus boiling water at atmospheric pressure is not considered to be a **Sterilising** agent and bacteriological tests have shown that spores of highly heat resistant organisms such as *stearomophilis aureous* are not killed by boiling water at atmospheric pressure, even when exposed to these conditions for several hours.

In order to subject the products to be sterilised to the required conditions, as given in *Figure 1*, dry saturated steam is used (superheated steam is not suitable), the corresponding pressure relationships are given in *Figure 4*.

In order to subject unwrapped bowls, instruments, utensils, etc, to a time/temperature relationship, as given in *Figure 1*, apparatus is required which in simple form is shown in *Figure 5*. This is a **Downward Displacement** steriliser. In order to determine the principle of downward displacement consider the relationship of air and steam, as shown in *Figure 6*: at any specific pressure steam is less dense than air. However, in a homogenous mixture of air and steam, the densities of air and steam are dependent upon their relative partial pressures — as the partial pressure of the air is reduced in an air/steam mixture its density is reduced. The relationship of the density of air in an air/steam mixture at a pressure of 206.84 k Pa compared with that of pure steam, is given in *Figure 7*.

Figure 6.

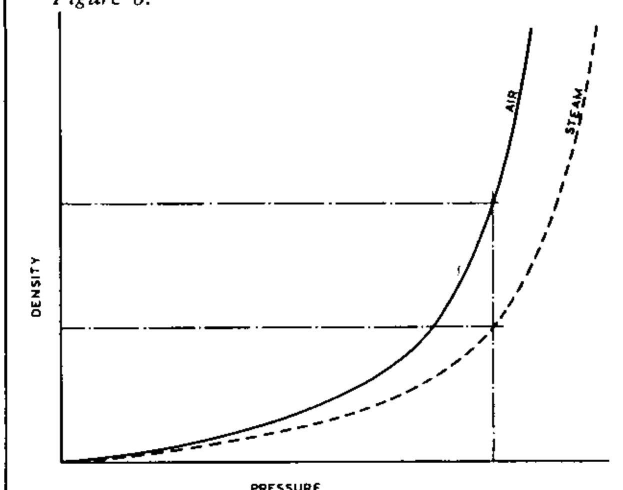
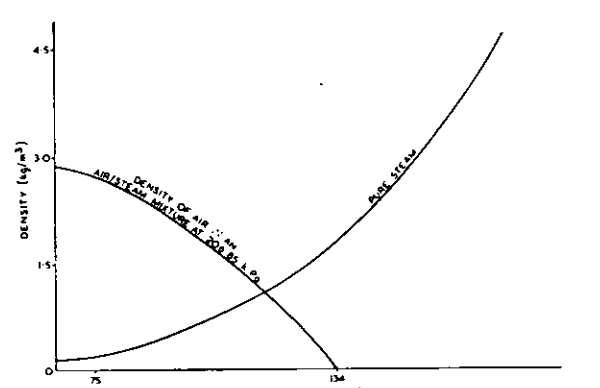


Figure 7.



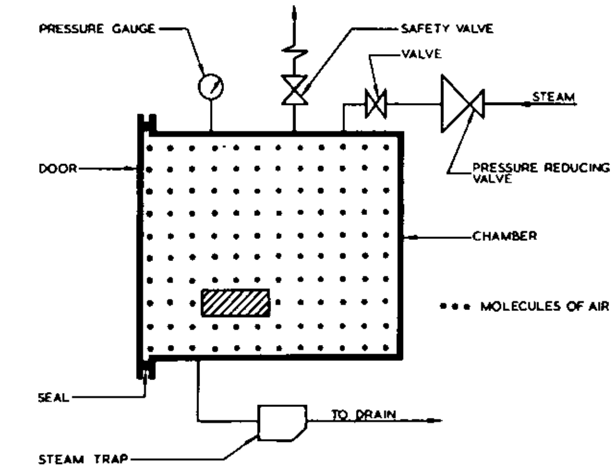


Figure 8.

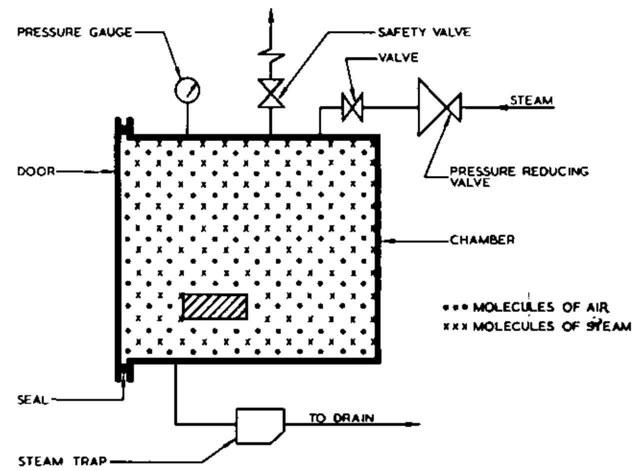


Figure 9.

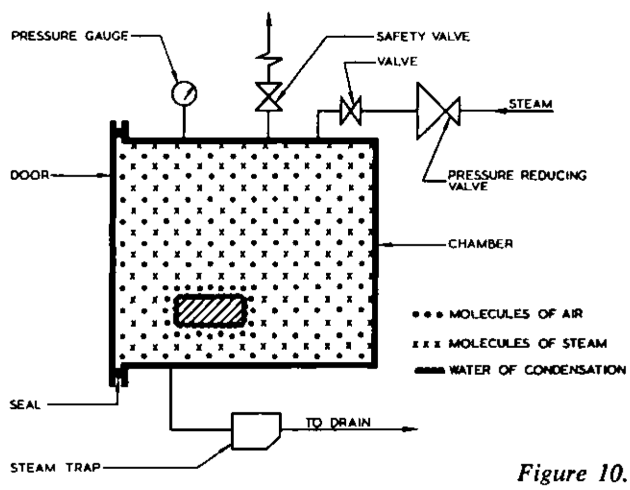


Figure 10.

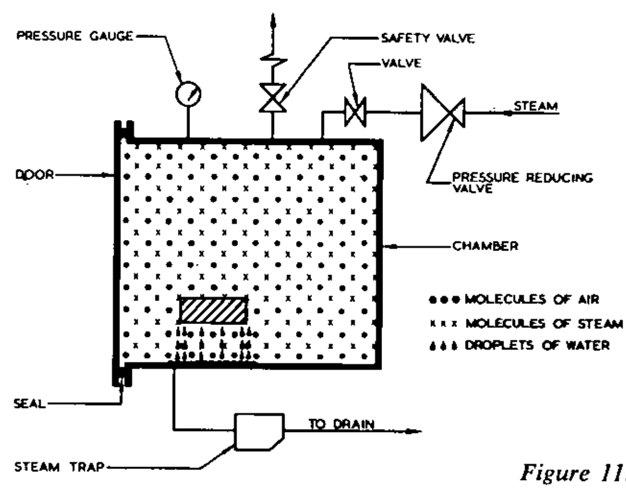


Figure 11.

To appreciate the downward displacement of air, consider the following stages in the cycle. Time being discrete: —

a. The steriliser is loaded with a metallic block, the surfaces of which it is desired to sterilise. The block is thus surrounded by molecules of air (see *Figure 8*);

b. The steam is now turned on and the block now becomes surrounded by a mixture of air and steam (*Figure 9*);

c. In the next discrete interval of time, those molecules of steam nearest the block give up their latent heat and the situation is as in *Figure 10*, the block having a thin coat of water surrounded by a layer of molecules of air. Now the air has been separated from the air/steam mixture and conditions related to *Figure 11* apply. The air having the greatest density falls under gravity, together with the droplets of water of condensation, to the bottom of the steriliser chamber and out via the chamber drain;

d. The air molecules and some of the water of condensation having dispersed towards the chamber drain allows more molecules of the air/steam mixture to be in close proximity to the surface of the metal block. Thus the process moves between stages c. and d. and, under these separating conditions, the air and the water are removed from the chamber. This is the principle of **Downward Displacement.**

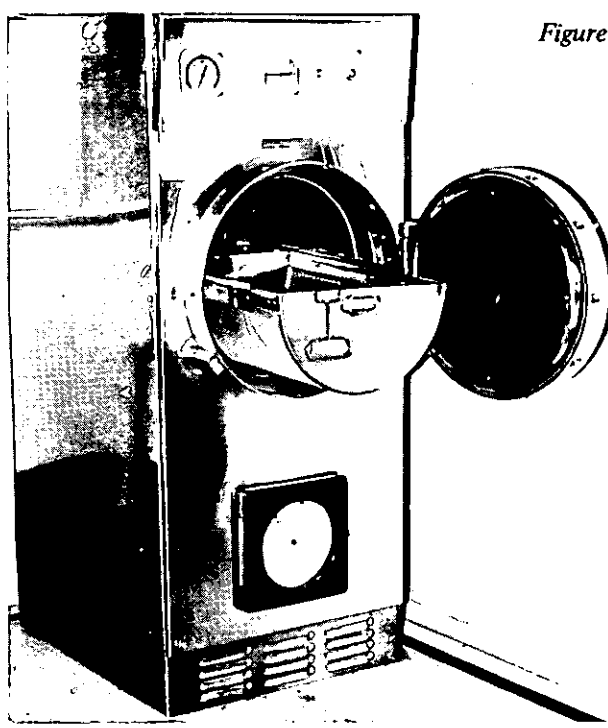


Figure 12

Obviously, in practice, articles requiring sterilisation would be placed in the chamber so that the air and water of condensation disperse under gravity and are not held on the upper surface, as would be the case of the block in *Figure 8*. *Figures 12* and *13* show a downward displacement steriliser used for the sterilisation of theatre instruments, utensils, etc.

Before 1957, dressings, gowns, drapes and other porous materials were sterilised in downward displacement type sterilisers. These were manually controlled, the operator opening and closing a number of hand valves in accordance with a set of written instructions. In order to obtain a more rapid evacuation of air from the chamber, it was usual for a vacuum of approximately 13.5 k Pa absolute to be drawn by means of a steam ejector, the remaining air being removed by downward displacement.

Figure 13.

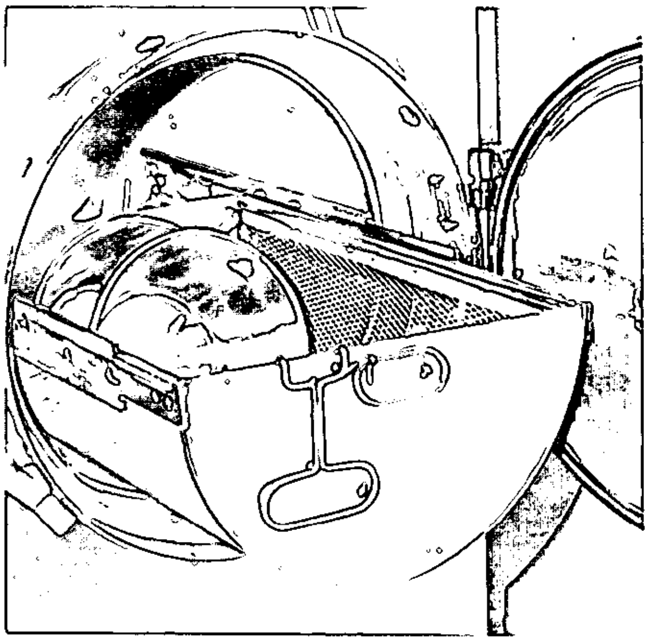
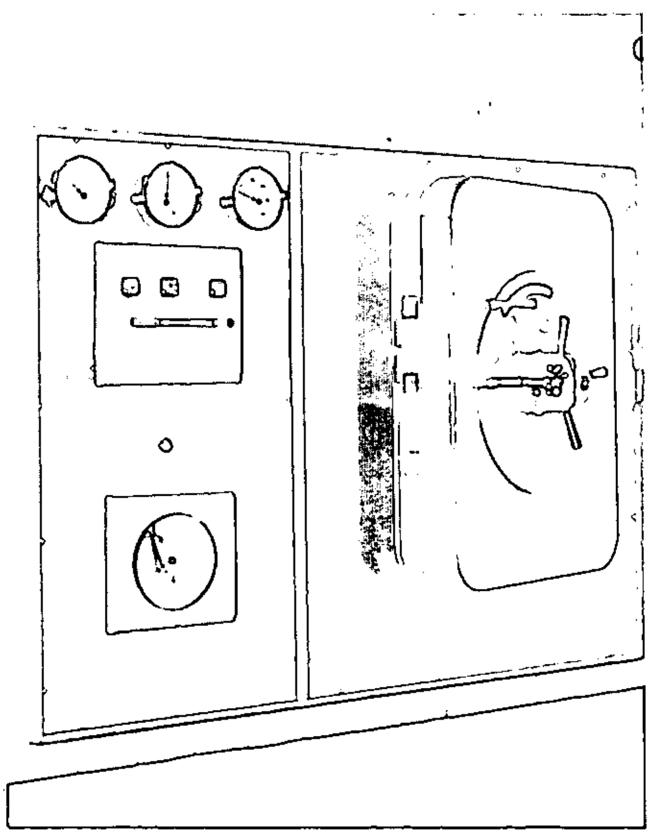


Figure 14.



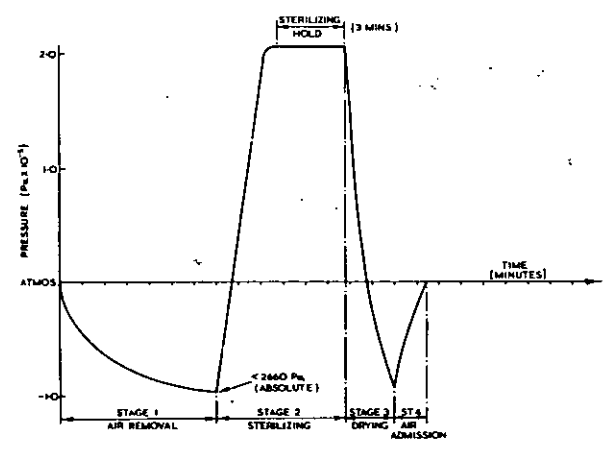
In 1957, a number of pathologists and bacteriologists investigated the temperatures achieved in different types of articles, using thermocouples placed in the centre of packs. The results of these investigations showed that, in practice, sterilising temperature was seldom achieved and also that the temperature measured was in a pocket of air and thus any bacteria in this zone could not be considered to be subjected to moist heat conditions.

Downward displacement of air from porous materials is slow, and varies with the standard of packing. Even though articles were packed in vertical lamina form, no definite time could be ascertained from which it was possible to always be sure that all the air had displaced and the whole of the articles subjected to steam at the sterilising temperature for a sufficient period of time.

Further research was carried out using more efficient vacuum systems to obtain a high level of air removal and it was observed that, when a pressure of 2.668 k Pa or less was achieved, this resulted in immediate penetration of the goods when steam was admitted to the steriliser chamber. This was confirmed by thermocouples placed in the goods and a thermocouple located in the chamber drain simultaneously indicating the same temperature.

As a result of this work, sterilisers using a time/temperature relationship of 134°C for three minutes, and achieving an initial vacuum of 2.668 k Pa or less, were manufactured and entered hospital service during 1960. Furthermore, for the first time these sterilisers had automatic control of the cycle, the process being initiated by pressing the starting button after the chamber was loaded and the door closed; it was not possible to open the door again until the full automatic cycle had been completed, thus largely removing the possibility of human error which existed with the previous manually controlled system. *Figure 14* shows such a steriliser, which became known as a **High Vacuum** Steriliser. *Figure 15* shows a typical pressure/time cycle and *Figure 16* the associated temper-

Figure 15.



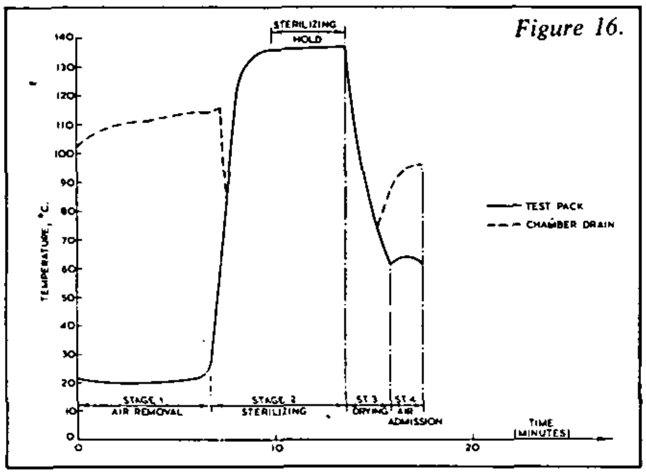


Figure 16.

ature/time cycle.

Although a considerable improvement upon the sterilisation of porous loads in a downward displacement type of steriliser, the original **High Vacuum** steriliser had two major drawbacks. Firstly, in order to achieve the level of vacuum required (less than 2.668 k Pa) an oil ring type of vacuum pump was necessary. Due to the fact that this pump had to accept steam and water vapour during the drying stage, emulsification of the oil took place with consequential loss of the level of vacuum it was possible to attain. This meant regular changing of the oil. Secondly, the partial pressure of the residual air in the free chamber space of the steriliser was determined by the maximum level of vacuum attained by the pump. With an increase in the chamber volume, evacuated to the same level of vacuum, there is thus a greater mass of residual air. When steam is admitted to the chamber during the sterilising stage, a large quantity of this air is distributed throughout the load. Thus when a large chamber size contains a small load size there is an increase in the amount of air in the load compared with the same small load in a small chamber size evacuated to the same level of vacuum. It is for this reason that the larger chamber sizes of **High Vacuum** type of steriliser could not pass the **Bowie and Dick** test[3] and that instructions were given to operators to fully load the chamber on every cycle.

Early in 1964 a manufacturer produced a porous load steriliser which overcame the problems of the **High Vacuum** type of steriliser. For the first time the reduction of air in the free chamber space and the load was accomplished by firstly drawing a vacuum and then proceeding to dilute the remaining air by injecting steam and then drawing a vacuum, re-injecting steam and then again drawing a vacuum. This was repeated several times. This pulsing technique, as it became known, could be set so that the number of pulses would dilute the air in the free chamber space and the load to less than 0.133 k Pa. Because the initial level of vacuum could now be greater than 2.668 k Pa, a water ring type pump was used thus eliminating the problem of emulsification of the oil, and because the partial air pressure was less than 0.133 k Pa, this type of cycle enabled the steriliser to pass the **Bowie and Dick** test on the larger chamber sizes as well as the smaller ones. *Figure 17* shows this type of steriliser and *Figures 18* and *19* its pressure/time and temperature/time cycles. Dilution of the air by pulsing techniques is now the method of air removal adopted in the UK by manufacturers. *Figures 20* to *25* show the pressure/time and temperature/time cycles for different manufacturers.


Figure 17.

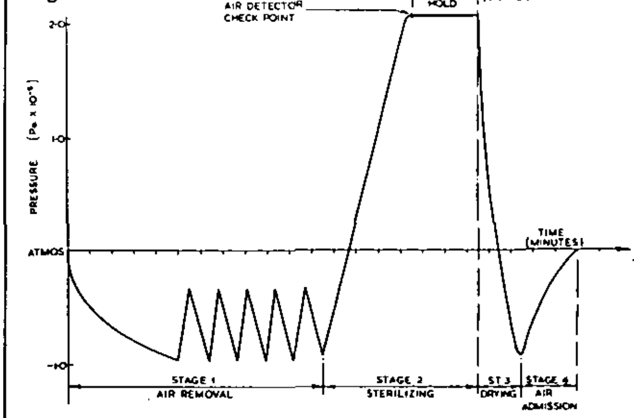
Figure 18.


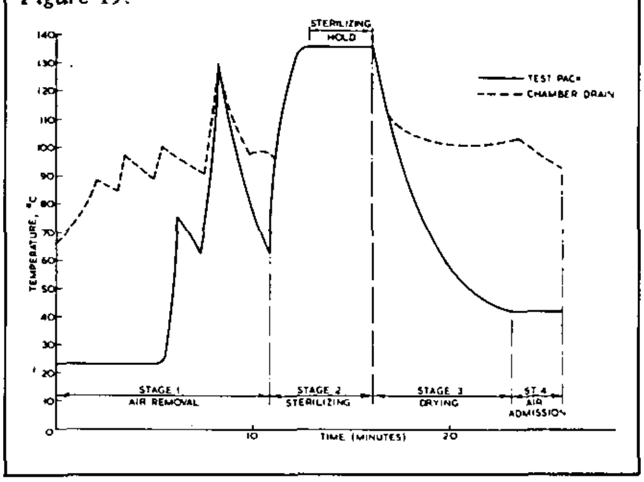
Figure 19.


Figure 20.

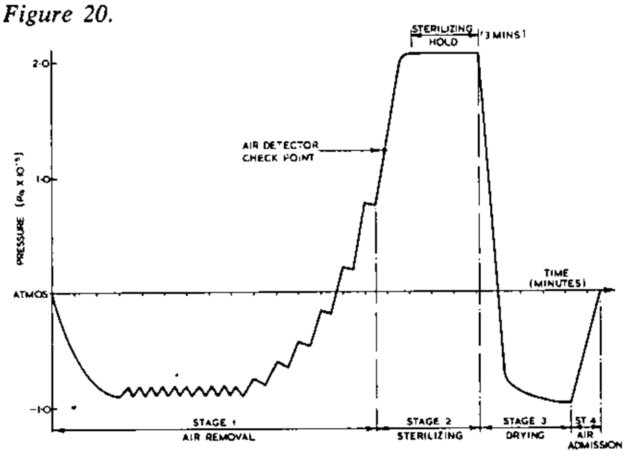


Figure 21.

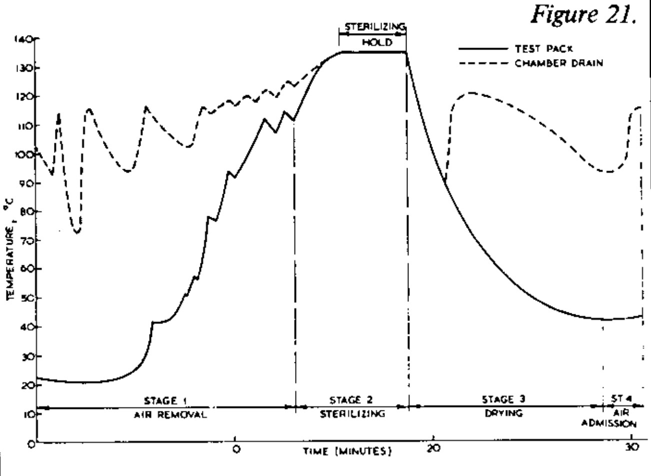


Figure 22.

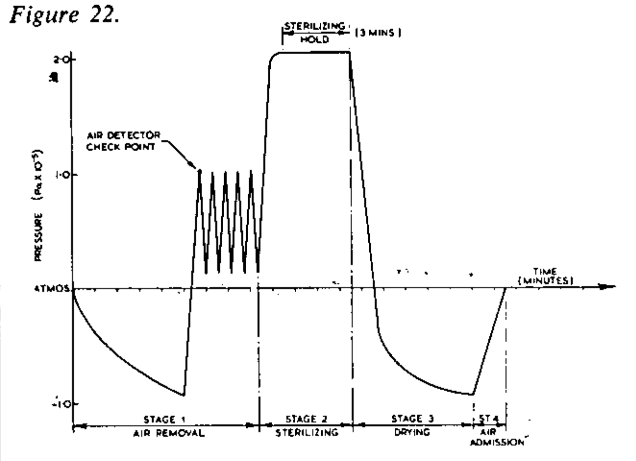


Figure 23.

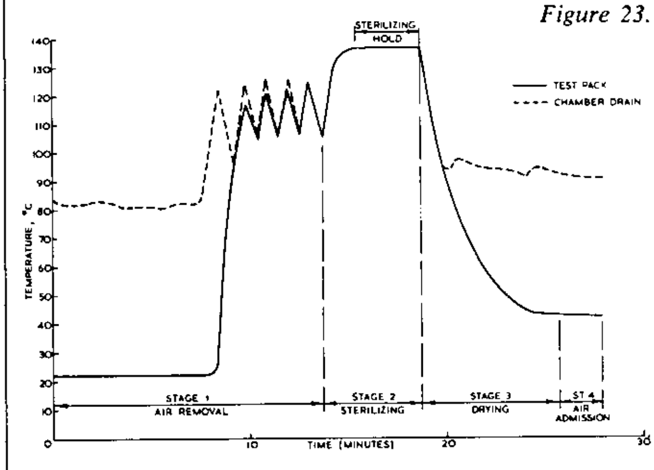


Figure 24.

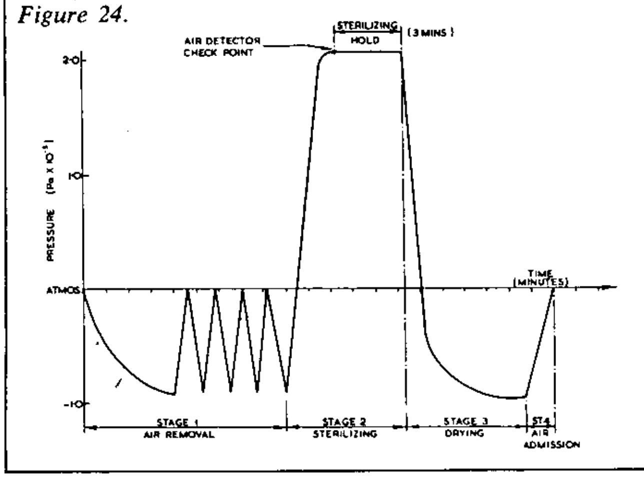
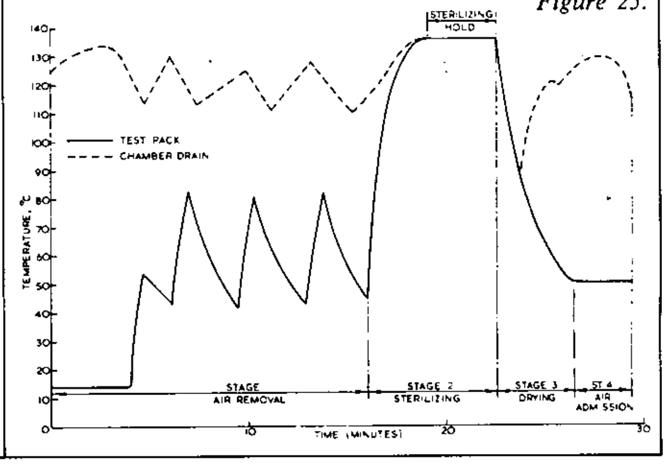


Figure 25.



The original pulsing porous load steriliser of 1964 was fitted for the first time with a device which detected whether or not the acceptable level of residual air in the free chamber space had been achieved on every cycle. This was a great technical advancement; ingress of air through a leaking door seal, pipe connections, etc, which could raise the amount of air to a level at which sterilisation of the load would be in jeopardy was now protected against. If air removal is below the standard to satisfy the **Bowie and Dick** test the **Air Detector,** as this device has come to be named, causes a non-sterile indicator to be displayed at the end of the cycle and, on modern sterilisers, the door remains locked, openable only by a special key. All sterilisers manufactured in the UK since 1969 must be fitted with an air detection system to satisfy this and are covered by the British Standard for porous load sterilisers. Basically, two types of air detectors are fitted,

a. the temperature depression type (*Figure 26*) where the air is separated out of a sample of the air/steam mixture passing down the chamber drain over a period of time. If the quantity of air collected is sufficient for the hot junction of the thermocouple to enter it there is a depression in temperature and this is noted by the monitoring system;

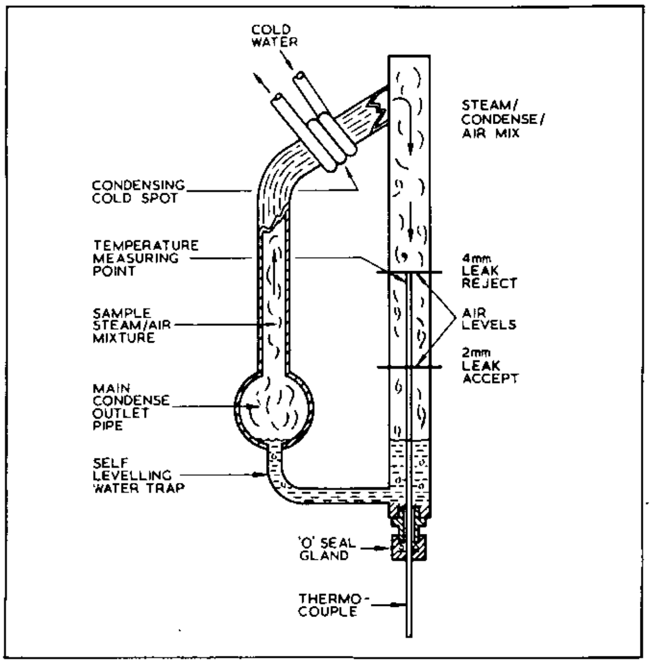


Figure 26.

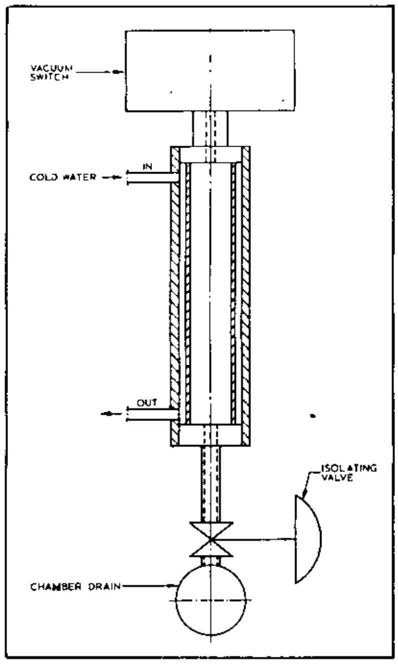


Figure 27.

Figure 28.

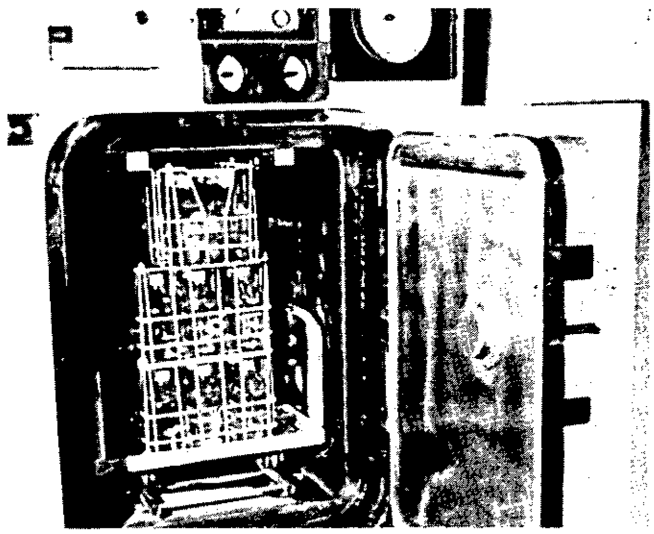
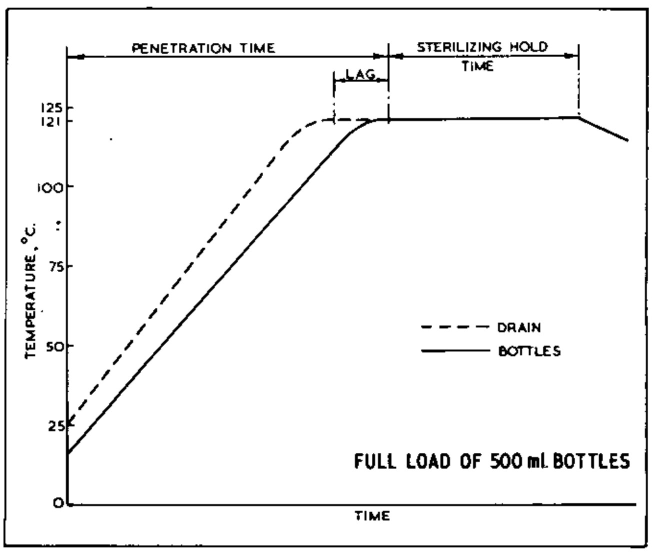


Figure 29.



b. the partial pressure type (*Figure 27*) where a sample of air/steam mixture in the free chamber space is taken during the initial part of the sterilising stage, condensed and the partial pressure of the air measured by a pressure transducer. The unacceptable level of partial pressure being monitored and forming part of the control system;

Type a. has the advantage of monitoring over a period of time, but has the disadvantage of being affected by changes in the final steam temperature;

Type b. has the disadvantage of only assessing the amount of air at the specific time the sample is taken. If air or other non-condensables enter the chamber with the steam during the sterilising stage after the sample is taken they are undetected.

Almost all the sterile aqueous fluids produced by hospital pharmacists are sterilised in sealed rigid containers (glass bottles) in a downward displacement type steriliser. In order to give a greater rate of production, and also to limit the breakdown of heat labile solutions, the steriliser is usually fitted with a water spray cooling device. Cool water is sprayed over the bottles after the sterilising stage. A typical steriliser is shown in *Figure 28.* The time/temperature relationship most commonly used being 121°C — 15 minutes.

Unlike the downward displacement bowl and instrument steriliser and the porous load steriliser, where the steam is in direct contact with the organisms, in the sterilisation of aqueous fluids in sealed rigid containers the steam is only the heating medium; the moisture necessary for moist heat sterilisation is provided by the aqueous fluid itself. This leads to a time lag between the chamber at sterilisation temperature and the aqueous fluid reaching sterilisation temperature. This time lag is greater for a small load than for a large load (see *Figures 29* and *30*). The heating up rate is also different for different bottle sizes (see *Figure 31*) and fill contents. These thermal lags have to be determined using thermo-metric means for every bottle size, fill content and load size for which the steriliser has to cater and, furthermore, the thermal lag has to be that of the slowest bottle within the load to reach sterilising temperature. During the commissioning of the steriliser,

Figure 30.

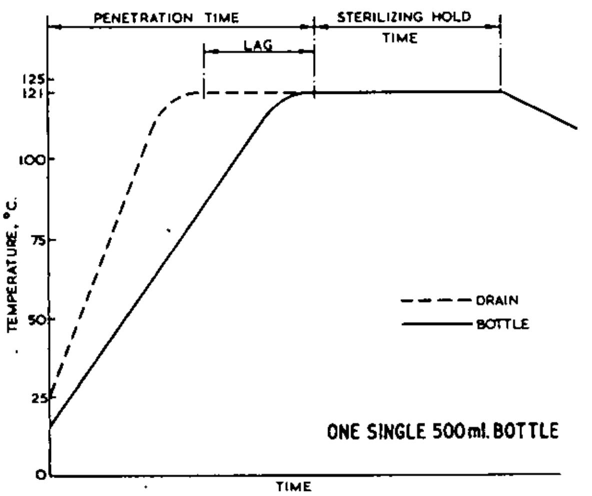
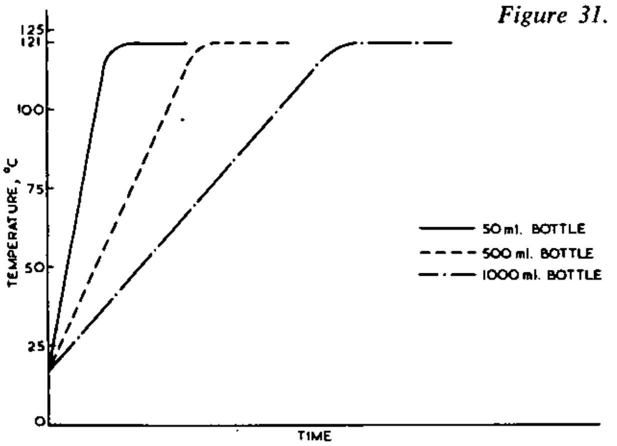


Figure 31.

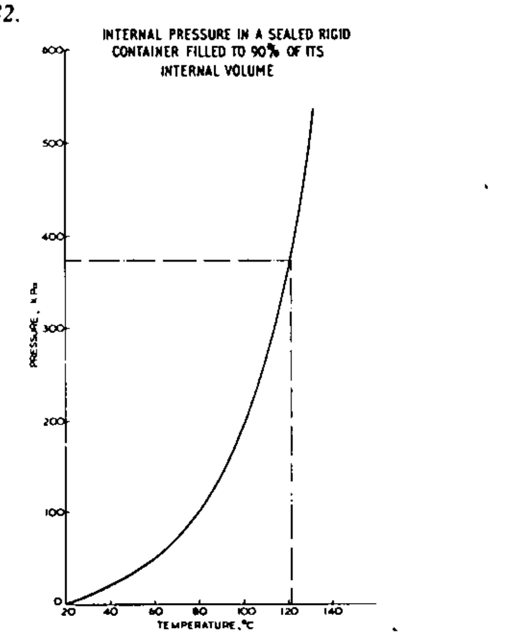


when these thermal lags are determined, chart recordings are obtained using the steriliser's chart recorder; these are designated the **Master Temperature Records** and are marked with the bottle size, fill content, batch size and steriliser plant number.

Transparent copies of these **Master Temperature Records** are kept by the hospital pharmacist to enable checks to be made against recordings for all subsequent cycles.

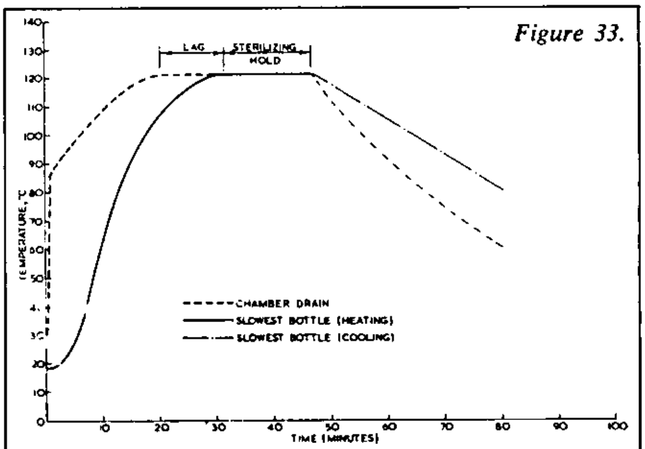
During the cycle, the rigid container and its closure are subjected to varying stress conditions. The internal pressure of a rigid container filled to 90% of its internal volume and at an original temperature of 20°C is shown in *Figure 32.* In the initial stages of the cycle the chamber pressure is greater than the internal pressure of the container, therefore if the seal does not provide a complete closure there is a risk of ingress into the bottle with possible chemical, bacteriological and particle contamination. Similarly, during the cooling stage where the internal pressure is much greater than the chamber pressure, there is a risk of loss of contents from the container resulting in a vacuum in the container after it has been removed from the steriliser and cooled to ambient temperature. Containers in which a vacuum exists are considered to have a high potential risk of microbial contamination during storage. From the above it is imperative that the container closure remains intact during the sterilising cycle and during storage.

Figure 32.



Because of the high internal pressures generated in a rigid container during the sterilising process, a load simulator is fitted in the chamber of the steriliser to prevent opening of the steriliser door until the containers and their closures are below 80°C. This device is designed to cool more slowly than the slowest cooling rate of any bottle in the load, see *Figure 33.*

Figure 33.



Considerable deliberations have been taking place recently in the UK regarding the problems of control (in both engineering and management terms) of sterilisers for aqueous fluids in rigid sealed containers, also in the suitability of the containers and their sealing systems. A revision of Hospital Technical Memorandum No. 10 is shortly to be issued giving details of the overall management of this type of steriliser and other types, both in terms of their use, maintenance and testing.

References

[1]**Medical Research Working Party on Pressure Steam Sterilisers** — *Lancet* 1959 p425.

[2]**European Pharmacopœia.**

[3]**The Bowie and Dick Autoclave Tape Test** — *Lancet* 1963, p586.

Forthcoming Conferences and Exhibitions

International IEE Conference on EHV Switching Equipment

The Power Division of the Institution of Electrical Engineers in association with the Institute of Electrical and Electronics Engineers (United Kingdom and Republic of Ireland Section) and the Institute of Mathematics and its Applications are organising an international conference on 'Developments in Design and Performance of EHV Switching Equipment', to be held at IEE, Savoy Place, London WC2 on November 26-28, 1979.

It is intended that the Conference will cover all aspects of the development, manufacture and testing of EHV circuit breakers, other switching devices and ancillary equipment for use on transmission networks throughout the world. It will take into account the application of EHV switching devices and the need to observe environmental requirements. The main aspects to be covered in the Conference programme are:

1. Ratings and Performance Requirements;
2. Effects of Changing Performance Requirements on the Design of Circuit Breakers and Other Switching Devices;
3. Progress in Arc Interruption, Insulation Technology and Test Methods;
4. Developments in Ancillary Equipment.

The Organising Committee invites offers of contributions for consideration for inclusion in the programme.

Intending authors should note the following deadline dates:
Receipt of synopses, December 1, 1978; Notification of provisional acceptance of synopses, January, 1979; Receipt of full text for final review, May 7, 1979.

The working language will be English.

For further details, contact the IEE Conference Department, Savoy Place, London WC2R 0BL. Tel: 01-240 1871, ext 261.

London H & V Show

A number of manufacturers will be exhibiting new products which include heat pumps, fan coils, controls and boilers at the H & V Index London Exhibition, to be held at the West Centre Hotel on November 22 and 23.

There will be over 100 stands at the show covering all types of heating and air-conditioning. It will give London-based engineers a convenient opportunity of seeing a broad range of equipment and suppliers.

The show is open from 10.00 to 8.00 on Wednesday, November 22 and 10.00 to 4.00 on Thursday, November 23.

Invitation tickets may be obtained from the organisers, H & V Index (Telephone: Upper Warlingham 2374).

Designing for Safety/Security

A One-day Symposium organised by the Building Construction Forum in association with the British Security Industry Association and the British Fire Protection Systems Association at the Institute of Civil Engineers, Great George Street, London SW1, on November 21, 1978.

Concepts of safety and security are changing. They used to be concerned primarily with means of escape from buildings in the event of disaster. The dangers arising from unauthorised entry to buildings were not thought to be so important.

The Symposium will bring together experts in different fields and marks a major step forward in the evolution of a new philosophy of security and safety in a world troubled by increasing technological hazards and human violence.

Application to the Institute of Civil Engineers, 1-7 Great George Street, London SW1. Telephone: 01-839 3611.

Book Reviews

Basic Telecommunications for Emergency Medical Services

James E. McCorkle, Eugene L. Nagel, Donald G. Penterman, Robert A. Mason. Published by: Ballinger Publishing Company, Cambridge, Massachusetts, USA.

Price: £8.85.

A new book from the Ballinger press dealing with an associated health subject. This company have recently presented in the States a number of first class books on related health subjects such as 'Health Planning', 'Community Planning', 'Health Care' and 'Emergency Medical Care' — all subjects which are currently of interest in their country, and about which varying views are continually being expressed.

This book on Basic Telecommunications would appear to be no exception to the rule. As usual with American publishers it is well presented, beautifully bound and extensively illustrated.

The objective of this book is to provide non-communication personnel involved in developing an emergency medical services system with a good general understanding of the application, design and implementation of a supporting EMS communication system.

In reading this book I was constantly reminded that its entire content was written and based on the American scene. Whether the various systems dealt with can be applied in this country or not, EMS staff involved will be better able to judge than I.

Engineers, without doubt, will find this book informative and well worth the time spent reading it.

R. G. SMITH
Hon Librarian

Product News

Intensive Care Ventilators

Sifam metres have been chosen by the Cape Engineering Company Limited for their new 2000 Intensive Care Ventilator. They are also standardising on Sifam collet-fixing knobs for the controls. Instrument panels on the 2000 have been designed to accommodate the bezel mounting 'Clarity Focus' metres and black matt-finish knobs with grey caps. Metre dials are black with white markings. Pointers are finished in red phosphorescent paint to be more easily read in dim light conditions.

Many Cape Intensive Care Ventilators are in use in intensive care medical units in this country and overseas. Their purpose is to enforce breathing by patients unable to do so voluntarily — inspiration is achieved by a bellows chamber and tube connecting to the patient, and expiration is via a one-way valve.

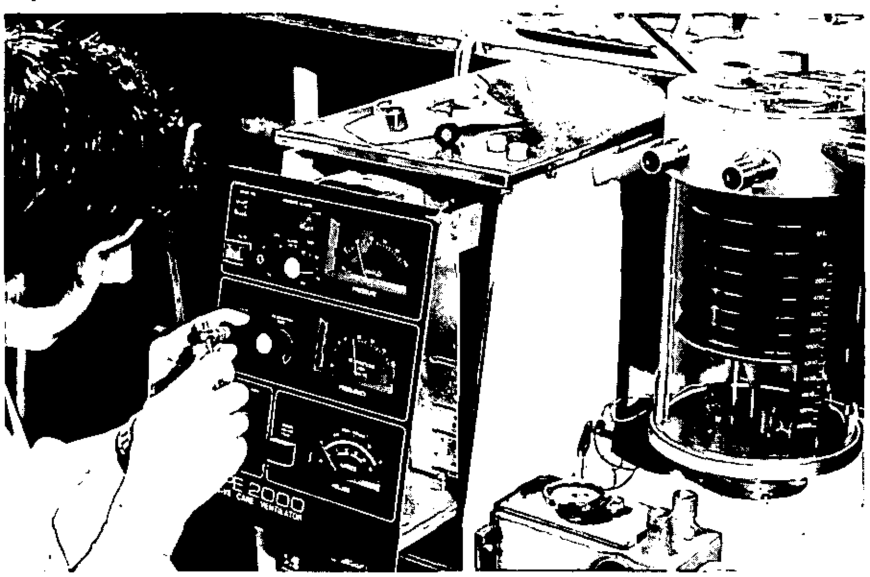
Electronic control systems provide for adjustment of respiration frequency, ratio of inspiration to expiration, and tidal volume. The three Sifam metres indicate precisely 'pressure', 'respirations per minute', and 'volume' by litres.

The manufacturers emphasise the need for absolute reliability in their apparatus: 'if a metre gave a wrong reading it could be a matter of life or death, so our components are chosen carefully. We chose Sifam taut-band metres primarily for their robustness because units often have to be moved around quickly.

'Patients can also have their own units and move them about at will. The matching Sifam knobs stand up to heavy or hurried handling, and they lock solidly onto the shafts without danger of their twisting and taking up a false position'.

Further details from: Sifam Limited, Woodland Road, Torquay TQ2 7AY. Tel: 0803 (Torquay) 63822, or from Cape Engineering Company Limited, Cape Road, Warwick CV34 5DL. Tel: 0926 (Warwick) 46421.

Cape Intensive Care Ventilator.



IAC Acoustic Consultancy Services

A new publication, now available from the Industrial Acoustics Company of Staines, Middlesex, details the services offered by their Acoustic Consultancy Service.

Industrial Acoustics Company have thirty years' experience in noise control technology: indeed many developments in this field can be traced to original research carried out by the company, including duct silencer design, and the concept of the prefabricated audiology room. The company's test procedures have also been adopted as basic standards for the performance of many acoustic products.

A fund of theoretical knowledge and practical experience of today's highly sophisticated noise control technology can be drawn upon by those seeking to overcome potential or existing noise problems.

At the planning stage of building projects, the IAC Acoustic Consultancy Service will undertake responsibility for the prediction and control of noise and vibration, both internal and external, caused by plant rooms, air-conditioning systems and other services. In addition, criteria for controlled environments, such as audiological research laboratories, lecture theatres, speech and music broadcasting and recording studios, can be defined, and optimum designs recommended. Remedial treatment for the reduction of unacceptable noise levels found in completed projects can also significantly improve the overall environment.

Whatever the application, the IAC Acoustic Consultancy Service say that they can offer a positive and economic solution.

The work of the Acoustic Consultancy Service is backed by survey teams performing site measurements of acoustic parameters to British standards, assessing the nature of the problem and providing an accurate data base for the optimum solution.

Their new publication, containing many full colour illustrations, is available on request from *Industrial Acoustics Company, Ltd, Walton House, Central Trading Estate, Staines, Middlesex. Telephone: Staines 56251.*

Conveyors in Hospitals

Whether the need is to move medical records, pharmaceuticals, X-rays, blood or pathological specimens within a hospital, a good internal communications network is essential. The alternative is to use valuable staff time doing nothing more than carrying things around.

DD Lamson have just published a booklet on this subject and although they manufacture various types of conveyor systems, it is not a product description. The booklet describes the specific needs for communication of patients' records, blood needed urgently (how many messengers can get it smoothly to the casualty unit at 20 mph?), laboratories' test work and other instances.

The booklet 'Hospital Systems' is available free of charge from DD Lamson Ltd, Gosport, Hants.

Multimeter Chart Recorder

A highly versatile Portable Pressure Sensitive Recording Multimeter is now available from PIL Ltd. The 'Multiscript' looks and operates like a multimeter using a single selector range switch, but has the additional advantage of being a Chart Recorder with 59mm writing width.

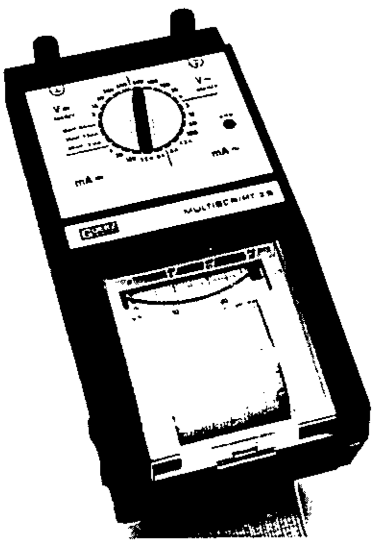
The '2S' is for general purpose use and has 27 ranges covering AC/DC voltages up to 600V and AC/DC current up to 6A.

The '3S' has a 20Kohm/V sensitivity and 22 measuring ranges AC/DC voltage up to 500V and a DC current of 50μA to 1A.

Both are available as mains or battery models and as part of the Unigor family, shunts, thermocouples and CT's are available to extend the basic ranges. The dimensions are 170 × 110 × 105mm, weighing 2.5kg.

For further information, please contact: PIL Ltd, Instrument House, 212 Ilderton Road, London SE15 1NT, or Telephone: 01-639 0155.

Multimeter Chart Recorder.



Complete Commercial Heating Pump Range

Single phase versions of the Grundfos UPS 40 Commercial Circulators have recently been launched in the UK. The new pumps complete their range of Industrial Heating pumps.

To coincide with the availability of the new pumps a major promotion supporting the UPS 40 range directed at Grundfos' heating pump stockists, consultants and contractors has been launched by the company.

The Grundfos UPS 40 pumps, available in single and twin head versions, fill the gap between the Company's Light Commercial circulators and the larger UPS 50 Multispeed range. The pumps incorporate a number of new features to ensure that they are sufficiently flexible in operation to suit the most advanced and efficient heating systems. At the same time Grundfos designers have ensured that the circulators consume as little power as possible.

Other special features, such as stainless steel rotor cans and impellers, together with ceramic shafts and bearings are common to all pumps in the multispeed range.

Every pump is tested under simulated working conditions at 90°C, and all models carry a 12-month guarantee.

Serviceability is a major design consideration and the Company has recently introduced a range of replacement pump heads for the commercial circulator range, to simplify service requirements in the event of pump failure or breakdown.

The manufacturers say that "The arrival of the single phase UPS 40 models means that our range of commercial heating pumps is now complete. We can now offer a suitable pump for the majority of commercial heating applications. The objective of the promotion is to enable stockists to build up an adequate supply of not only the UPS 40 pumps but our entire range of commercial heating circulators which is in ever-increasing demand."

For further information contact: Grundfos Pumps Ltd, Grovebury Road, Leighton Buzzard, Beds. Tel: Leighton Buzzard 4876.

New Standard Deionisers

Aquastat, the water treatment specialists, have introduced a standard range of four fully-automatic, two-bed deionisers for water flow rates of up to 1,200 imperial gallons per hour.

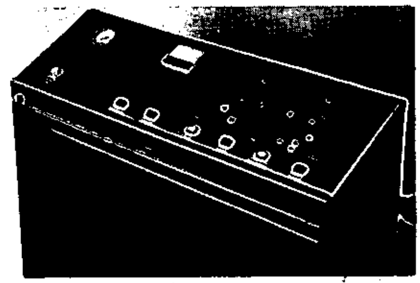
The new Aquastat DM deionisers are designed for treating make-up water to closed-circulation systems, for small boilers, hospital and laboratory applications, and for low-capacity production plant.

Control Console

The same control console, with a mimic diagram of the water circuit, is used for each of the four DM systems, linked to two-bed deionisers of the required capacity.

The console shows all valves in the water circuit. It indicates when the system is in backwash, what the current stage of regeneration is, and it signals the failure of any solenoid valve. The console provides automatic or manual control and can be used to hold the regeneration sequence at any time.

New Standard Deionisers.



No Minimum Flow Rate

The unit uses full-flow, 1 inch internal valves and an integral recirculation pump which ensures properly deionised water at all times, even when plant is shut down. The pump has no minimum flow rate.

Maximum flow rates and regeneration capacities for the four Aquastat DM deionisers, at 100 mg/1 TDS, are: DM1, 330 igph/3,000 gallons; DM2, 440 igph/5,500 gallons; DM3, 900 igph/10,280 gallons and DM4, 1,200 igph/13,700 gallons.

Details from Aquastat Ltd, Romney House, Tufton Street, London SW1. Tel: 01-799 3647.

New Compensator and Expansion Loop Catalogue From BSS

The new catalogue by British Steam Specialists Ltd gives details of the range of expansion loops and pipeline compensators available through their local branch office warehouses, and provides sufficient detail for basic selection while stressing the point that application information is required to ensure that the correct unit is supplied.

Sizes available, construction, recommended applications and suggested fitting procedures are contained within the catalogue's pages, covering Axial, Articulated and Angled Compensators, Neoprene Compensators, Loop Type Expansion Joints and miscellaneous units including PTFE Bellows Compensators, Gimbal-Tied Compensators, Asbestos Connecting Pieces and Seamless Brass Hose.

Further details from BSS, Fleet House, Lee Circle, Leicester. Tel: Leicester 23232.

Classified Advertisements

APPOINTMENTS AND SITUATIONS VACANT

BUILDING SERVICES ENGINEERS

(HVAC AND ELECTRICAL)

Major Dublin based Consulting Engineers have vacancies for Senior Engineers and Technicians to work on design and supervision of installations in a wide range of interesting projects — Hospital, Laboratories, Colleges, Chemical Plants, etc.

Minimum Qualifications:—

SENIOR ENGINEERS/ENGINEERS

Degree or equivalent, plus 5/2 years' appropriate experience in a responsible position.

TECHNICIANS

Apprenticeship and / or appropriate Technician Diploma, plus 2 years' post training experience.

Permanent positions with good promotion prospects. Opportunities for multidiscipline project work; good working conditions in modern open-plan office in Dublin suburbs; good salaries with regular reviews; flex-time; free Pension, Life Assurance and Sickness and Accident Insurance Schemes; moving expenses and other benefits to suitably qualified and experienced staff.

Please write with relevant details to: B. K. Reilly, Varming Mulcahy Reilly Associates, Tramway House, Dartry Road, Dublin 6.

REGIONAL ENGINEER

Salary Scale £11,022-£13,335

Applications for this post are invited from Chartered Engineers currently employed by a Health Authority in England.

Further details and application form from: The RHA Section, Personnel Division, Cumberland House, 200 Broad Street, Birmingham (021 643 5781, Ext. 69) to whom completed application forms should be submitted by: November 30, 1978.

West Midlands Regional Health Authority

ESSEX AREA HEALTH AUTHORITY

Colchester District

MANAGE OUR NEW CSSD/TSSU SERVICE

We are looking for an experienced professional to set up and develop our new CSSD/TSSU Service.

This new Service will be based at Severalls Hospital. Colchester, and it is envisaged that it will be operational in January. 1979. Therefore this post should appeal to candidates keen to join a project at its early stages and will provide total involvement in the planning and development of this new district venture.

Reporting directly to the Support Services Manager the successful candidate will also be responsible for our existing CSSD located at Black Notley Hospital, some 19 miles from Colchester. The post is a key one and carries responsibility for providing a comprehensive sterile supply service to a District serving a population of 260.000 with a bed complement of some 3,600.

Other duties will include the recruitment and supervision of staff, the management and control of the unit's budget and the maintenance of good comunication links with Senior Medical and Nursing Staff.

Colchester as a place to live and work has much to offer. There are several popular East Coast resorts close at hand as well as the unspoilt Constable countryside. Housing generally within the district is available at prices below the national average.

In addition to a salary which is wthin the scale £4.421 to £5.326 there will be an incentive bonus scheme introduced. Relocation expenses will be paid in approved cases and there is the possibility of a staff house.

If you would like more information and an application form, write to Paul Taylor, Personnel Officer, Colchester Health District, Turner Road, Colchester, Essex. Telephone: Colchester 47171.

Closing date for receipt of completed applications: Wednesday, November 22, 1978.

KENSINGTON & CHELSEA & WESTMINSTER
AREA HEALTH AUTHORITY (TEACHING)
NORTH EAST DISTRICT (TEACHING)

ASSISTANT ENGINEERS

(West 1 and Hendon)

Vacancies for two Assistant Engineers have arisen within this busy London Teaching District.

Based in W1 and at Hendon, respectively, the successful candidates will be responsible to the Hospital Engineer for the management of Engineering Services within the Works Department. These positions offer an excellent opportunity for an engineer to gain wide experience in the Hospital Engineering field. Part-time study leave may be made available.

Applicants should have served a recognised engineering apprenticeship and possess a minimum qualification of ONC in Engineering.

Single accommodation may be made available at a moderate rental.

Salary: £4,242-£4,731, inclusive (under review).

Application forms may be obtained from, and informal discussions held with, John Richards, District Engineer, The Middlesex Hospital, Mortimer Street, London W1. Tel: 01-636 8333, Ext 7577.

Closing date: November 20, 1978.

TECHNICAL ENGINEER

Private Hospital

Libya £10,000-£12,000 NET

Our client, the Oil Industry Medical Society, needs a resourceful engineer to maintain a small but well-equipped 30-bed Hospital in Tripoli, Libya, with the assistance of a local foreman and three craftsmen.

In addition to the general maintenance of the Hospital with the associated staff villas and apartments, and including the electrical, water and air conditioning systems, he will be required to maintain all types of medical equipment in departments such as Intensive Care, Operating Theatre, Maternity, X-Ray, Dental and the Laboratory and an adequate stock of required spares.

A mature individual with an H.N.C. or higher qualification, combined with ten years experience in Hospital Engineering, is required for this appointment. Previous overseas experience in the Middle East and a knowledge of Arabic would be an advantage but is not essential.

Furnished apartments are provided and benefits include generous allowances, a loan for car purchase, 32 days annual travel-paid leave in U.K. and an interim vacation.

Applicants should write, in complete confidence, giving career details and quoting reference LIBYA/FR to:

F. Rothwell, C.B.E., Whitehead Technical Services Limited, The Whitehead Consulting Group, 21 Wigmore Street, London W1H 9LA.

1974 WHITEHEAD

Hertfordshire Area Health Authority

North District

DISTRICT WORKS OFFICER

Salary Scale (District 2)

£7,566-£9,006

Due to retirement of the present holder, this important post in the Works Department is now vacant.

Applicants for the post must have a sound knowledge of the Management of the Works function in large building complexes. Responsibilities cover the whole range of maintenance activities in respect of building, engineering and equipment.

The District comprises all urban areas of Hitchin and Stevenage and the rural areas surrounding these towns. There are six main hospitals with a total bed content of around 900, and many smaller Health Service buildings.

Only suitably qualified and experienced applicants will be considered and the essential and appropriate minimum qualifications are as specified in relevant circulars.

Those seriously considering applying may obtain further details by telephoning the Area Works Officer, Mr. A. J. Barrett, on Hemel Hempstead 61663, Ext. 270.

Application form and Job Description obtainable from the Area Personnel Officer, Hertfordshire Area Health Authority, Hamilton House, 111 Marlowes, Hemel Hempstead, Herts. Telephone: Hemel Hempstead 61663, Ext. 278.

Closing date: December 1, 1978.

HOSPITAL ENGINEERING

SUBSCRIPTION ORDER/RENEWAL

for non-members of the Institute of Hospital Engineering wishing to subscribe to the Journal

Please send me one year's supply of Hospital Engineering commencing with the January/February issue 1979 (published February 2). This is a renewal/subscription.*

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Telephone: 01-623 2235

*Delete as applicable

Closing Dates

Recruitment advertisers are requested to set closing dates no earlier than three weeks after publication date of the Journal

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

Mersey Regional Health Authority

REGIONAL WORKS DEPARTMENT

BUILDING SERVICES ENGINEERS

Applications are invited from suitably qualified and experienced mechanical and electrical engineers for positions on the staff of the Regional Engineer.

The work is varied and interesting and is involved with engineering services in Health Service premises throughout the Mersey Region.

Posts are available in the following categories:

Design, coordination and Contract Management of Heating,
Air Conditioning or Electrical Services,
Commissioning of completed installations,
Advising on operation and maintenance,
Advising on energy conservation.

Posts are available in the following grades:

MAIN GRADE ENGINEER

REF. 105
Salary scale £3,771 to £6,810 per annum

The starting salary within this range will depend upon qualifications, age and experience. Ideally applicants should be Corporate Members of the I.Mech.E., I.E.E., I.E.R.E. or C.I.B.S., or have successfully completed a degree course in Environmental Engineering.

Graduate members (or equivalent in current terminology) of one of the above institutions may also be considered.

TECHNICAL ASSISTANT

GRADE I — REF. 106
Salary scale £4,641 to £5,478 per annum

Applicants should possess the appropriate H.N.C. or alternative qualification and 8 years relevant experience, or an O.N.C. or alternative qualification and 10 years relevant experience.

TECHNICAL ASSISTANT

GRADE II — REF. 107
Salary scale £4,158 to £4,638 per annum

Applicants should possess the appropriate H.N.C. or alternative qualification and 5 years relevant experience, or an O.N.C. or alternative qualification and 7 years relevant experience.

TECHNICAL ASSISTANT

GRADE III — REF. 108
Salary scale £3,009 to £4,089

Applicants should possess the appropriate H.N.C. or alternative qualification and 2 years relevant experience, or an O.N.C. or alternative qualification and 4 years relevant experience.

5-day 38-hour week
N.H.S. Superannuation scheme applies to all posts.
Application forms and job descriptions available from the Regional Personnel Officer, Wilberforce House, The Strand, Liverpool L2 7RW, to whom completed forms should be returned by 24th November 1978.
Please quote the appropriate reference number.

LONDON BOROUGH OF HARINGEY

BOROUGH ENGINEER & SURVEYOR'S

MAINTENANCE & CONSTRUCTION WORKS

ASSISTANT MECHANICAL SUPERVISOR

T.4

£5,392-£5,862 pa inclusive of Compensatory Payment for a 40-hour week

Assistant Mechanical Supervisor (male/female) required to manage at first line level a mechanical works section carrying out a wide range of maintenance and minor improvement work on heating systems, ventilation plant and kitchen equipment.

Candidates should have wide technical experience, a City & Guilds Certificate in Plant Engineering and current experience of man management.

Details obtainable from Borough Engineer and Surveyor, Hornsey Town Hall, The Broadway, Crouch End, N8. Tel: 01-340 3220, Ext 136 or 14.

Applications returnable by November 24, 1978.

KING'S HEALTH DISTRICT (TEACHING)

Assistant Engineers

Salary: £4,242-£4,731 inclusive

The minimum requirement for these posts is an ONC in Electrical / Mechanical Engineering or equivalent qualifications. The jobs offer excellent training opportunities and full support given for further studies. Previous experience of maintenance engineering (mechanical/electrical) preferable.

Application form and job description for the above posts from Nigel Sewell, Deputy Administrator, Dulwich Hospital, East Dulwich Grove, London SE22 8PT. Tel: 01-693 3377, ext 3209.

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"Oh, does he now? Perhaps you'd better leave the long words to the doctors and listen to me"

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All of 'em wanting things you can only get from steam and hot water and compressed air.

Which is why those Spirax people are worth getting to know. They're not just experienced in manufacturing industry but all those places where the end product is people's comfort.

While I think of it, get yourself enrolled in one of their Postal Steam Courses. I took it years ago and I learned a lot. And I've seen somewhere they do another on Compressed Air. Have a word with them."

WORDS OF WISDOM **2**

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