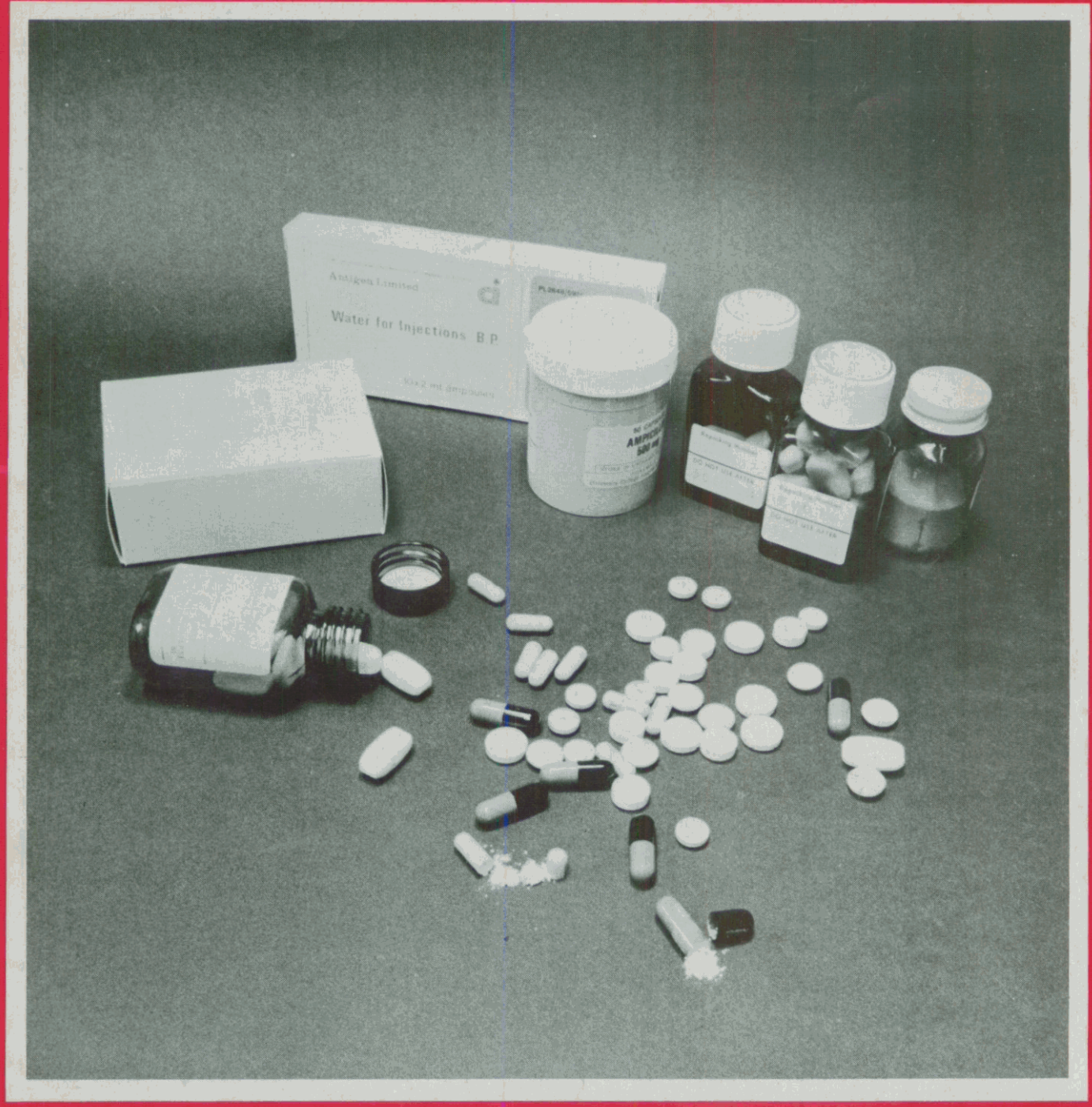
The Journal of the Institute of Hospital Engineering February 1982

HOSPITAL ENGINEERING



The Medicines Act 1968
The role of the engineer

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HOSPITAL ENGINEERING

The Journal of the Institute of Hospital Engineering

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Volume 36 No. 1 February 1982

Front Cover:
The products of the hospital pharmacy — see *The Medicines Act 1968 — the role of the engineer.* (page 4).

Opinion

This is the first of a regular series of contributed articles on matters of current interest. Any member of the Institute is welcome to submit an article of between 250 and 900 words (approximately) to the Editor for consideration.

Readers are reminded that the Institute and the Editor do not necessarily share the views expressed in the articles which are not official announcements.

Be Enthusiastic: It's Contagious

(Motto on 1982 Calendar)

Think BIG! This certainly seems to have been the theme over the past few years, and I might add, with much success. Someone, somewhere must take the credit for daring to suggest that an organisation could designate a year for a particular campaign.

A year isn't a commodity one can purchase and have sole rights to. It belongs to everyone to spend as they will, but if some organisation sets out with enthusiasm to declare that a year will be devoted to a particular cause, then everyone becomes involved in or is swept along by that campaign.

The more modest of us may have declared 1981 as being 'Painting the House Year' but our publicity will have been confined to reaching our wife and neighbours (who have perhaps heard it all before anyway). If you didn't succeed in honouring your commitment last year why not take advertising space in your local newspaper (or better still, *Hospital Engineering*), and announce that 1982 will be 'Paint the House Year'? (The writer has no shares in Harris Brushes or Dulux).

We have had the Year of the Child, The Year of Disabled People, and Hospital Energy Conservation Year.

But why the need to nominate a year for a particular purpose? It's not as though the rights of the child weren't considered before or that the needs of the disabled people were ignored. Nor can we say that conservation of energy was not tackled before 1980. Dare I suggest that the motive behind these designated years was the need to make people more acutely aware of the causes and to persuade them to participate in them? That there was some apathy towards these causes in the years preceeding the year of their designation? If so, have we as a nation failed to take full advantage of Information Technology available to commerce and industry?

The Government has designated 1982 'Information Technology Year' to promote awareness and greater use of Information Technology in an attempt to persuade potential users to apply this science as a means of improving efficiency and productivity, and to enable the UK supply industry to improve its share of trading in this field.

The NHS has been asked to participate in this campaign and the details are spelled out in HN(81)35, HN(FP)(81)40.

Having noted the contents of the Health Notice, you may be in a dilemma as to where to file it: subject heading, HN number, or even start a new subject file, but in nine months time will you be able to retrieve it without too much searching? Should we (the NHS), in our participative role in 'I.T. Year', begin to develop a central (or regional) system of information storage and retrieval?

Over the years, a wealth of material is published by the DHSS and Regional Health Authorities for dissemination to districts and we in the service are blessed with an expertise at the DHSS and Regions second to none when it comes to offering guidance and advice on Works matters.

Norms, advice, guidance, hazards, technical clauses and papers are given freely and in abundance but because they are not always required at the time of receipt, they are put on file. Then comes the time when some particular information is wanted and you can remember seeing some written matter on the subject some months, or even years ago, but you cannot recall its format or where it was likely to be filed. How helpful it would be if the subject matter could be stored in some master memory bank, and all we had to do was to look up from an index the appropriate code for that subject. This would lead to a printout of a comprehensive index listing all relevant papers, guidance, Health Notices etc., ever produced. Mandatory guidance and relevant hazards could be identified by an asterisk, etc.

Such a retrieval system would require very careful planning and I envisage a Primary Index Code for various main headings.

Take for example *Laboratory Mechanical Services*. The response to the Primary Index Code would be a printout or VDU display listing relevant sub-sections with their own Secondary Index Codes, e.g. Ventilation, Water Services, Heating, Laboratory Gases, Isotope Sinks, Fire Precautions, Drainage Systems, Fume Cabinets, etc. Selection of the Secondary Index Code for say Drainage systems would list standard technical clauses (appropriate also to other locations of drainage systems), reference to Howie, Health and Safety publications and HN Hazards issued on the subject, e.g. HN(81)6 detailing dangers in respect of waste pipes handling Picric Acid.

I know that that hazard exists but the Consulting Engineer or a recently appointed design engineer on the Works Staff may not be aware of this hazard.

Information is only as good as its dissemination, and at the right time, i.e. when it is required. We can't rely on our memories to recall guidance issued some two years ago.

Such guidance and advice are indispensable tools in the execution of our work. A major and valuable role which the NHS could play in 'Information Technology Year' is to apply available technology to develop a system for quick and easy retrieval of the written word.

Dick Bowie.

Institute News

International Congress 1982

The Biennial International Congress of the IFHE will be held in Amsterdam from 9-14 May. The Conference organisers have now distributed the Conference brochure, which incorporates forms relating to conference hotel and travel programme.

It is interesting to note that one day of the technical programme is devoted to visits to hospitals in and near Amsterdam.

The social programme includes an Official Reception hosted by the Burgomaster and Alderman of Amsterdam, and a Dinner Dance on another evening.

The Institute office will try to answer questions and help in any way. Alternatively, enquirers may wish to contact the Conference Organisers direct. They are: *Organisatie Bureau Amsterdam BV, Europaplein, 1078 GZ Amsterdam, The Netherlands. Tel: 010-31-20 440807.*

Lawrence Turner on IFHE Council

Lawrence Turner, Immediate Past President of the Institute, has consented to be one of the Institute's representatives on Council of the International Federation of Hospital Engineering, and he will assume office in May of this year.

Mr. Turner's enthusiastic interest in matters of an international nature, and particularly as they affect hospital engineering, is well-known, and he has attended a previous Congress of the International Federation. He has also played host, both during courses and at his own home, to those who attended the first International Seminar, which the Institute held at the Hospital Estate Management and Engineeering Centre, Falfield, in September 1979.

Council, therefore is very pleased indeed that Mr Turner will continue to be involved in the Institute's affairs in this way.

Branches circulation to their Members

As an experiment, and to effect substantial savings (particularly in relation to postages) Branches will circularise their members much less frequently during 1982.

It is planned that Branches will mail direct to their members giving the coming six months' programme of events.

As a 'back-up' and to support members' diaries, a regular column is being introduced into the Journal, which will set out all Branches' meetings arranged for six to eight weeks ahead.

MEMBERS ARE REMINDED that where it is customary for them to advise their Branch Honorary Secretary of the intention to attend a meeting they are requested to continue to do so, preferably at least seven days before the event.

The co-operation of members is sought by Council to make this system work.

Apart from the very considerable savings in expenditure that will result it will mean an appreciable lightening of the heavy work load borne by Honorary Branch Officers.

Annual Conference — Entertainment

Visit to the Royal Shakespeare Theatre.

During the 1982 Annual Conference, which is to be held at Stratford-upon-Avon from 19-21 May, the opportunity will be taken to attend a performance at the Royal Shakespeare Theatre.

It is not possible at this stage to say what play is being performed on the night in question (Wednesday 19 May). However a block booking has been made in the Institute's name, and as Conference registrations are received members will be given an opportunity to take up theatre tickets, on a first-come, first-served basis.

A Correction

In the December issue of *Hospital Engineering* we published a list of new members.

Mr John Leigh, a new Associate Member, has asked us to point out that he is no longer associated with RDL International, but is working as a consultant architect.

North Western Branch

This revised notice supersedes the one which appeared in the Newsletter.

Forthcoming events

Timing for all meetings are 6 for 6.30p.m.

Wednesday 17th February A paper on SPC Telephone Exchanges at the NWRHA Offices, Manchester.

Thursday 18th March AGM followed by paper on Static Engineering, at the Bolton Medical Institute.

Wednesday 21st April *Visit to* Alexandra Hospital, Cheadle, near Stockport.

Wednesday 12th May Talk by IMI Bailey Valves Ltd on the installation and maintenance of valves. The talk will be held at the Hope Hospital Post Graduate Medical Centre, Salford.

Congratulations

Mr David Cunliffe, Branch Committee member and Area Engineer for Rochdale Area Health Authority, has been successful in obtaining a BSc in Electronic Engineering Studies at Manchester Polytechnic.

Taking four years to complete the course on a part-time basis, he is one of only five successful candidates considered eligible for the Honours Extension Course.

Our congratulations to David on his remarkable achievement.

International Hospital Symposium

The 10th Internationales Krankenhaussymposion is to be held in Berlin from the 10 to the 13 March 1982.

The areas for discussion include 'The hospital within the health system' and 'Safeguarding public health services at a time of decreased resources'.

There will also be a series of working groups, some of which would be of interest to Hospital Engineers and visits to both old and new hospitals in the Berlin area.

The conference will be held in English as well as German, and tickets cost DM275 (about £65), with a reduced price of DM250 for bookings received by 28th February.

Accommodation is available through Verkehrsamt Berlin, Europa-Centre, 1000 Berlin 30, Telephone (030) 21 23 2598/2789.

Tickets and further information from Institut für Krankenhausbau, Technische Universität Berlin, Strasse des 17. Juni 135, 1000 Berlin 12. Telephone (030) 314 3750.

This article first appeared as a paper at the Annual Conference last May. The author is the Principal Pharmacist as the Pharmaceutical Quality Control Laboratory, North Nottingham Teaching District.

The Medicines Act 1968

J M SPRAKE B Pharm PhD FRSC C Chem MPS

Introduction

Pharmaceutical preparations manufactured in hospitals can be divided into the two broad classes of sterile and non-sterile products. Requirements for the manufacture of sterile products are the more stringent, and it is in this area that the Medicines Act. 1968 has made its greatest impact, and in which the greatest demands are made of the hospital engineer. The Medicines Act 1968 is not the only factor, however. BS. 5295, which appeared in 1976, sets standards in this country for different classes of environment, whilst the new edition of HTM 10 deals with sterilizers in much greater detail than the old, and compliance in detail with both of these documents is expected by the Medicines Inspectorate. The hospital engineer is chiefly involved with pharmaceutical production in connection with ventilation systems, laminar flow cabinets, autoclaves and stills, and each of these will be considered later. First, however, let us briefly trace the steps leading to the present situation, with particular reference to the Medicines Act 1968.

The Medicines Act 1968

In Great Britain, there have been standards laid down for medicinal products, and the raw materials from which they are made, for over a century in a succession of Pharmacopoeias. However, it was not until the advent of the Medicines Act 1968 that the actual process of manufacture was brought under legal control. Before this there were no checks on the suitability and condition of the manufacturer's premises and equipment, the manufacturing process, the documentation kept, the precautions taken to ensure the quality of the product, or the adequacy of personnel and staff training. The Medicines Act changed all this, in that it contained in effect a requirement for a proper system of quality assurance.

At first, it was intended that the requirements of the Medicines Act regarding manufacturing would apply only to the pharmaceutical industry, but it soon became apparent that for consistency the same standards should be applied to hospital manufacturing. The necessary hospital circular appeared in 1975, and since then members of the Medicines Inspectorate have been paying official visits to hospitals.

One of the results of applying the Medicines Act to hospital pharmacy has been the advent of the quality control pharmacist, who exercises his function independently of the production pharmacist, and takes the final decision on whether a particular batch of product is satisfactory and can be released for use.

The Guide to Good Pharmaceutical Manufacturing Practice

It is not possible in a legal document like the Medicines Act 1968 to give practical advice, and for this purpose the *Guide to Good Pharmaceutical Manufacturing Practice*, or 'orange guide', was published in 1971. The second edition appeared in 1977. The 'orange guide' is not a legal document, and has no statutory force. Nevertheless Medicines Inspectors use the guide as their basis of assessment, and of course a manufacturer has to have Medicines Inspectorate approval to be able to continue manufacturing. This means that when the advice in the guide is not being followed, or where some alternative has been adopted, it is necessary to be able to justify this to the Inspectorate.

Engineering Considerations

Earlier, four points were mentioned where the Engineering input is particularly important.

First, there is the matter of ventilation systems. Processes in sterile products units are carried out in what are termed by the orange guide 'aseptic areas' and 'clean areas'. These areas are in fact small rooms, with standards of environment

corresponding respectively to Class 1 and Class 2 of BS 5295. The BS defines four classes of environmental cleanliness in terms of size and number of airborne particles, the highest class of environment being class 1. A further requirement is that there should be at least twenty air changes per hour.

In order to achieve these standards, the rooms in question must be supplied with filtered air of suitable quality. It is preferable that there should be a terminal filter at each point of input into an area. Sometimes, however, there is only one final filter, situated near to the fan motor, with the ducting branching subsequently. In these cases it is more difficult to achieve a high standard of air entering the rooms.

In our experience, the quality of air entering an aseptic area must be well inside class 1, if this class is to be achieved within the room itself. For a clean area, which requires a class 2 environment, the standard of air entering should also be class 1, or a very good class 2. The quality of air is most conveniently checked with an air particle counter.

A factor which can be overlooked in the design of clean and aseptic areas is that of temperature. The laminar flow cabinets which are stationed in these areas generate a considerable amount of heat, and the air being taken in by the ventilation system may already be fairly warm. Thus on a hot day working conditions can become quite intolerable, particularly since the workers in these areas normally wear trouser suits, gloves, hoods and face masks. It is therefore most important that ventilation plant be fitted with efficient cooling systems.

Second, there are the laminar flow cabinets which are placed in clean and aseptic areas in order to provide extra protection to the product at the point of handling. The cabinets provide class 1 air, and carry any particles shed by the operator away from the product.

It is most important that these cabinets function satisfactorily, and again their performance is most easily checked with an air particle counter, in conjunction if desired with a dioctyl phthalate smoke generator. In our experience, leaks through the filter itself are in most cases associated with visible damage. Much more common are leaks around the edge of the filter, which may be particularly bad in the corners. In some cases, filters in laminar flow cabinets are changed by the hospital engineers, in others by the manufacturers themselves. In the latter case, we have sometimes subsequently detected leaks, even when the contractor has purported to test the cabinet himself with a particle counter, and has issued a certificate to the effect that the performance is satisfactory.

Thirdly, there is the necessity to ensure a good supply of distilled water. Certain hospitals have experienced considerable difficulties with thermocompressor stills, although the evidence would suggest that these perform satisfactorily provided that the water supply is suitably pre-treated, and the still is run continuously rather than being closed down nightly. One problem with such stills can be the difficulty of getting replacement parts quickly. In a recent instance the condensing chamber of a still cracked, and the supplier did not carry the part in stock. By the time that he had had a new one manufactured in this country — a more certain course than sending abroad for it — and had fitted it, several months had elapsed. Subsequent failures of other components associated with the heated storage tank and ring mains system meant that the still in question was out of use for most of a twelve month period.

Difficulties can arise with the older type Manesty still, although they are much simpler than the thermocompressor type. In particular, if the rate of flow of the feed water is too high, then adequate degassing does not occur, and the pH of the distilled water is lowered due to dissolved carbon dioxide. The water may then fail the official test for pH, and be unsuitable for use in sterile production. What is required is a sensitive valve, perhaps together with a header tank, to maintain a constant flow to the still despite fluctuations in mains pressure. A simple rule of thumb is that the feed water should run at such a rate that the stem of the still is just too hot to keep one's hand on at a point one-third of the way up.

Finally, there is the matter of sterilizers. Most of the products from a sterile products unit are aqueous solutions which are sterilised in a bottled fluids sterilizer, although some are non-aqueous preparations which are sterilized in a hot air sterilizer. At local level, the maintenance engineer, production pharmacist and quality controller must all be satisfied that the sterilization process is effective. The new HTM 10 gives much detailed guidance on sterilizers, and some major points are as follows.

The concept of Master Temperature Records (MTRs) requires that a sufficient number should be produced to cover the range of batch sizes to be sterilized. No doubt different Regions and Areas will be at different stages with regard to the production of MTRs. In our experience problems seem to arise in achieving sufficiently reproducible cycles with older autoclaves for this purpose, and sometimes a number of components have to be changed when MTRs are first produced. Even then, the characteristics of the cycle may change appreciably within a few weeks or months. Thus we have in one hospital a production unit with two continuous spray cooling autoclaves, and six months after the determination of MTRs it was observed that the heating-up time as recorded from the chamber drain had decreased for each autoclave by 5-10 minutes for no apparent reason. The length of time at sterilizing temperature was the same, however. It seemed to us that although the chamber drain was reaching sterilizing temperature faster, that did not mean that the coldest bottle in the load was following suit. It was therefore necessary to produce a new set of MTRs for each autoclave. Since then, similar problems have been encountered in a second production unit.

Performance tests for bottled fluids sterilizers are described in Appendix 11 of HTM 10, and the maintenance engineer is now involved in carrying out a weekly test, and a quarterly three-point thermocouple test, and possibly yearly tests as well. Regular planned preventative maintenance is also important.

It is the responsibility of the maintenance engineer to ensure that a plant history record is kept for each sterilizer, and this must include details of performance tests, irregularities, modifications, and all maintenance work, tests and checks. A copy of the PPM schedules should be included. Such detailed records have often not been made in the past. It is essential that the log be kept with the autoclave and be readily accessible to the production and quality control pharmacists, who must countersign it weekly.

The Medicines Inspectorate are of course very familiar with HTM 10,

and expect to see it implemented in full. Some older autoclaves do not comply, and replacement of, or modifications to equipment can take time. However, documentation and procedures can be introduced more quickly, and these days Medicines Inspectors certainly expect tc see plant history logs, and laid down details of PPM, and be assured that performance tests are being regularly carried out.

Effect of Lost Production Time

In conclusion, I would like to consider the effect of lost production time on the pharmacy sterile products unit.

Hospital production units exist primarily to make products which cannot be bought. However, there is usually some spare capacity, and this is generally used to manufacture products which are commercially available. When a production unit is out of action for a substantial length of time, stocks of the items produced begin to run down. Commercially available items are purchased from industry. Other items are sometimes obtained from industry as 'specials', at comparatively high prices, or other hospitals. In some cases the nearest commercially available item is used, although it may be less satisfactory for the intended purpose. Clearly a difficult situation has been created.

Consider the following example taken from one particular production unit. Out of forty weeks of production time, the amount of down time for various items of equipment was as follows:

	No. of weeks down time Out of 40
Large autoclave No. 1	24
Large autoclave No. 2	5
Small autoclave	39
Thermocompressor still No. 1	14
Thermocompressor still No. 2	1
Ventilation system	11
Bottle washer	2

The unit never had more than two weeks uninterrupted production, and never had everything working all at once. The actual amount of production was 27% of what had been estimated to be reasonable as a minimum.

What this example emphasises is that the production pharmacist is entirely dependent on the functioning of his equipment to maintain output. The situation is even more critical in a unit which has only one still and one autoclave. When one of these pieces of equipment stops functioning, then production of heat sterilised bottled fluids stops entirely. Often the fault is remedied quickly, but occasionally it can be several weeks before the equipment is working again. (Where autoclaves are concerned, it is not possible to continue production and stockpile batches for sterilization days or weeks in the future. Pharmaceutical products must be sterilized within two or three hours of preparation to prevent possible microbial spoilage).

There are a number of factors to be considered in connection with the planning and running of production units. First it is necessary at the planning stage to ensure that adequate back-up facilities are available to the unit. In some cases, back-up facilities such as a second autoclave and still have been omitted from units due to lack of space, or misleading claims by manufacturers as to the reliability of equipment, or pharmaceutical shortsightedness. In others, however, the situation has been forced upon the pharmacist in attempts to cut costs. Such cuts have very often proved to be false economies.

Secondly, there is the problem of replacement parts, and the difficulties caused when a manufacturer cannot supply for a lengthy period, which may run into months. Should Health Authorities carry more spare parts? Should the DHSS try to bring more pressure on manufacturers? This is certainly an area which needs some attention.

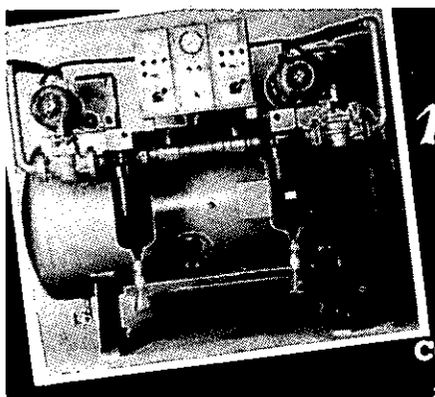
Thirdly, there is the question of conflicting demands upon the time of Engineering staff. If the main pharmacy autoclave has broken down again, and the ventilation system to the operating theatres has also ceased to function, then if there is a choice to be made naturally the ventilation unit will come first. Moreover, when a production unit is out of action for a day or two it is usually possible to deploy staff on other jobs. Nevertheless, it is essential that equipment malfunction in the pharmacy production unit should be treated as a matter of urgency, for when a unit is out of action for any length of time it can in effect cause a considerable financial loss.

This brings us to the question of the financial cost of lost production. It is not easy to determine exactly what it costs when a unit is not functional. Different studies have taken different factors into account, and reached different conclusions, and it would not be possible to quote any detailed figures here. One example which came to my notice, however, was that of a certain production unit which required a new chart recorder fitting to its bottled fluids sterilizer. The decision was taken locally that in order to save money the work would be carried out by hospital staff, rather than calling in a specialist firm. No account was taken of possible extra production time which might be lost. Because of certain engineering problems, the autoclave was out of action for twenty weeks. During that time, the cost of purchasing items which would otherwise have been manufactured in the unit was very considerable.

There was little that could be done in the way of savings to balance this loss. It was still necessary to pay the staff of the production unit, and to keep the unit operational, in order to continue with the production of items which did not require heat sterilization. Savings on such items as bottles, closures and raw materials were comparatively small. In the end the cost, in terms of lost production, of fitting a new chart recorder to a twelve year old autoclave was greater than the cost of buying and installing a completely new autoclave.

Clearly there is a need for pharmacists, engineers, administrators, and everyone concerned, to be much more cost conscious in planning and running production units. Equipment malfunction which is not rapidly corrected severely damages cost efficiency, and close liaison between pharmacists and engineers is vital in order that problems may be overcome quickly. Moreover loss of production for any length of time not only has considerably financial implications, but has a bad effect on staff morale. The whole question of the cost and efficiency of pharmaceutical production in hospitals is at present under close scrutiny by the DHSS.

Standards have risen markedly in recent years with regard to the whole field of pharmaceutical manufacturing, and these standards are being actively enforced by the Medicines Inspectorate as the result of the Medicines Act 1968. This, together with the necessity to increase the cost effectiveness of production units, is inevitably having a considerable impact on the hospital engineer.



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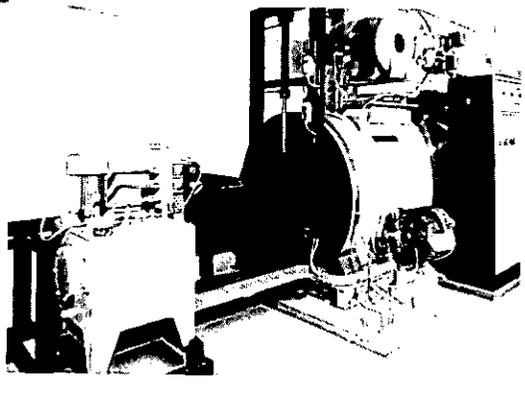


The author is Consultant Bacteriologist at the John Bonnett Clinical Laboratories, Cambridge Health District. He gave this paper at the Institute of Hospital Engineering Annual Conference in Sheffield in May, 1981.

Safety Cabinets

Testing and Maintenance

S W B NEWSOM MD FRCPath

Introduction

Interest in laboratory-acquired infection first really became apparent in the late 1940s, since when at least 6,000 such infections have been recorded. Some 80 - 85% have been 'silent', i.e. unrelated to a known accident, so are presumed to have followed inhalation of the infecting microbe. Most of the relevant germs do indeed survive well in air, and infect (sometimes in very small quantities) if inhaled. However, two important exceptions are typhoid, which is usually eaten; and Hepatitis B, which is picked up by contact with contaminated blood through cuts, abrasions, or needle jabs.

The obvious answer to infective aerosols is containment, and in 1954 Doctors *Lidwell* and *Williams* designed a small ventilated enclosure (a Safety Cabinet) for laboratory use, and similar units became standard equipment in most UK hospitals.

Current interest in Safety Cabinets began in the late 1960s with the realisation that some were so badly designed as to do more harm than good. A 'danger box' with a low (sometimes non-existent) air flow could retain an infective aerosol under the operator's nose for longer than the open bench with its normal air currents, sometimes amplified by the updraught of a Bunsen Burner. Other problems included poor maintenance (even of correctly designed units), and the introduction of 'Laminar Flow' units such as the clean bench and the recirculating vertical flow 'Safety Cabinet'. Some scientists regarded a clean bench as operator protection, when in fact it is quite the opposite — blowing aerosols at the operator.

These problems led to the initiation of my researches by Inter-Authority Study Group 9, sponsored by the Engineering Division of the DHSS, and since superseded by Study Group 10; and in due course to the generation of a British Standard — B.S. 5726.

Meanwhile, the whole topic was given an emotive amplification by the smallpox episodes at the London School of Tropical Medicine and at Birmingham University (incidentally neither are Health Service Premises), and the subsequent publication of the *Howie* Code of Practice, — all of which have served the cause of provision of adequate safety cabinets in laboratories.

The exhaust protective cabinet (Class I) is required for the hospital routine diagnostic laboratory, especially where Category B pathogens, such as tubercle bacilli, are handled. The recirculating unidirectional (Laminar) flow cabinet (Class II) is much more expensive, complex and hard to maintain. Fortunately the needs of hospitals (as opposed to research units) for Class II cabinets are strictly limited, indeed the radiopharmacy seems to be the main consumer. Thus this review will primarily concentrate on Class I cabinets, and will include comments on testing, installation, use and maintenance.

Testing

From the Health and Safety view the main parameter to test is operator protection. The B.S. approaches this in two ways:

Use of an adequate airflow — currently 0.75—1m/sec is specified through the working aperture of a Class I cabinet. (Higher levels may create excess turbulence and so decrease efficiency).

Use of a 'containment' test, mainly to detect leaks out through the working aperture, although filter integrity also requires testing.

Airflows

Patterns of airflows and the presence of gross leaks can be demonstrated easily with titanium tetrachloride smoke. An anemometer is needed to measure air velocity. The simplest type is a set of rotating vanes that wind a pointer round a dial. A more complex electronic version uses the vanes to generate electrical impulses to provide a direct reading and a recordable output; thus variations in airflow are more readily picked up.

Thermoanemometers depend on cooling of a hot wire or thermistor bead by the airflow. These also are direct reading and have a recordable output. The area sampled however is minute compared with the 10cm diameter of the vanes, so turbulence at the working aperture of a Class I cabinet leads to a very variable trace. If the area under the curve is integrated, the average flow approximates to that measured by a vane anemometer, although there may be troughs as low as 0.2m/sec in a cabinet running at 0.75.

Thus it is important to IGNORE the minimum readings of the thermoanemometer in this site. The electronic vane anemometer is preferable (*Figure 1*) because it produces a more damped trace, which nonetheless shows a $\pm$ 20% variation around mean airflow. The variation is

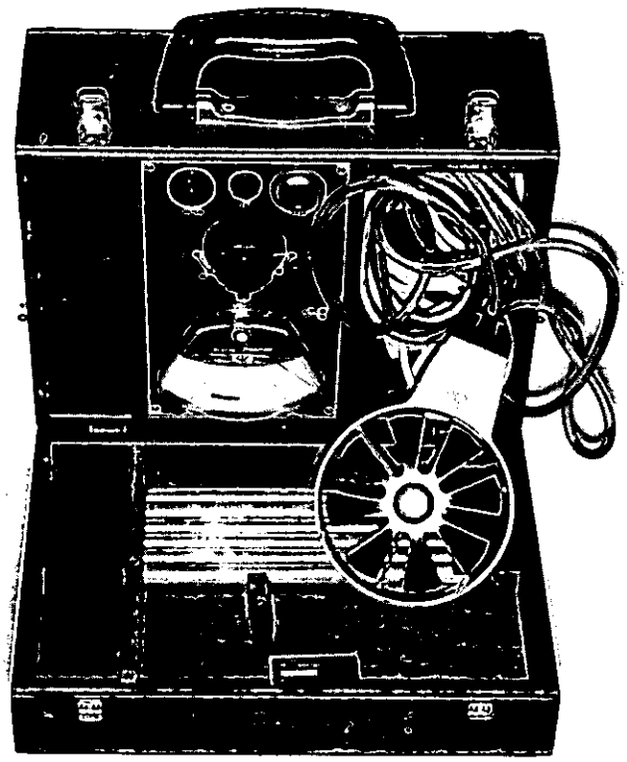


Figure 1: A Vane Anemometer.

increased by working at the cabinet, and by opening or shutting doors, particularly if the cabinet is sited in a small room.

The B.S. states that airflows must be measured at five sites across the working aperture of a Class I cabinet — the four corners and the centre. A cabinet sited sideways to the door of a small room may take in extra air at the side nearest the air supply at the expense of the further side. Testing airflows in the Class II cabinet is a complex affair. The inflow across the working aperture will vary from virtually zero at the top to a maximal at the bottom, and so cannot be measured directly. It can be derived in 3 ways:

Occlude the front (say with a plastic sheet) except for a hole just large enough to accommodate the anemometer, and relate the reading to the dimensions of the aperture.

Measure the airflow in the return air plenum, subtract the downflow and relate this to the working aperture.

Measure the dumped exhaust airflow, which should equal the inflow.

Measuring the downflow is easier, but must be done at several points to check for even flow; the standard requires no more than a $\pm$ 20% variation.

A recent acquisition of value has been a computer-operated anemometer, designed and built by Mr. A Breame of the Animal Virus Research Unit, Pirbright. This has a thermoanemometer probe fitted on a 70m track along which it runs, taking 500-1,000 readings of the airflow at each cm. The readings are fed into a microcomputer and mean, maximum and minimum, are printed out for each point; then the machine prints an 'airflow profile' based on the means.

Figures 2 and 3 show the value of this machine. *Figure 2a* was obtained by scanning the downflow of a Class II cabinet from back (left side) to front, with the probe 10" above the working aperture. The pattern is obviously interrupted by two troughs, which on inspection were seen to relate to the two fluorescent lights crossing the airflow beneath the supply filter. When the lamps were removed, a much smoother pattern *(Figure 2b)* was obtained. The air extract configuration can also disturb the 'Laminar' flow.

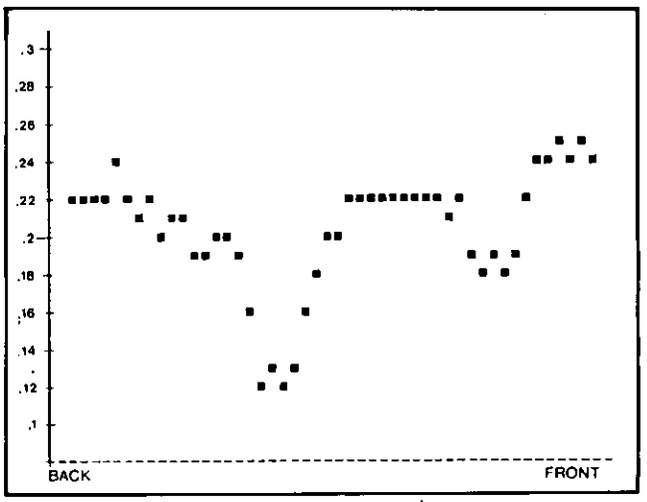
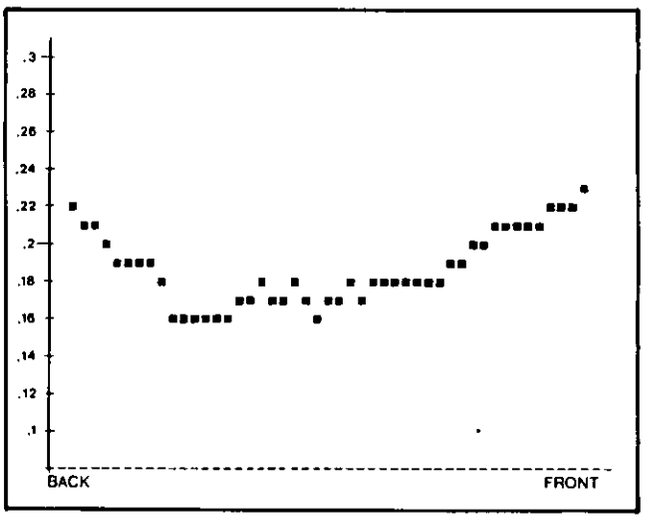


Figure 2a: Downflow profile of a Class II cabinet with lamps in place. Figures are airflow in m/sec. Reading at each cm.

Figure 2b: Downflow profile of a Class II cabinet with lamps removed.



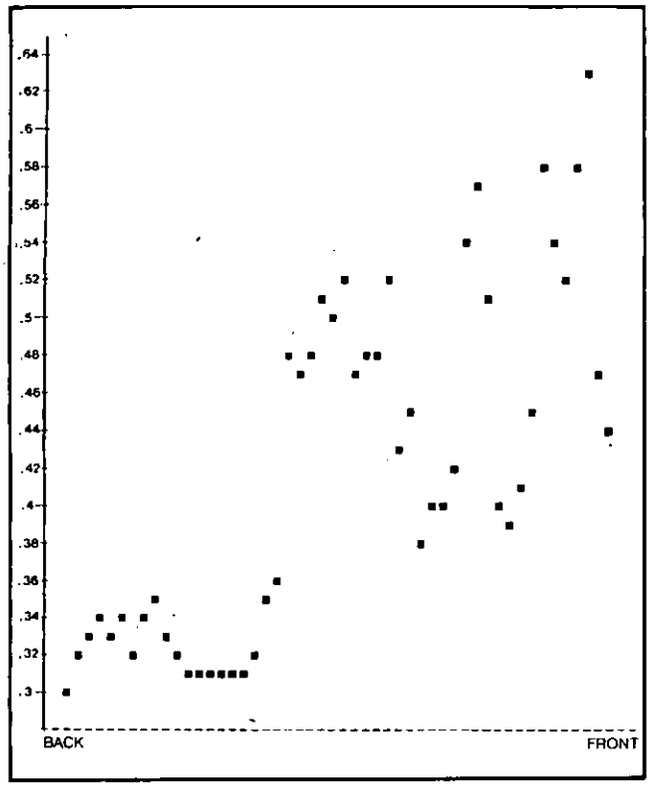
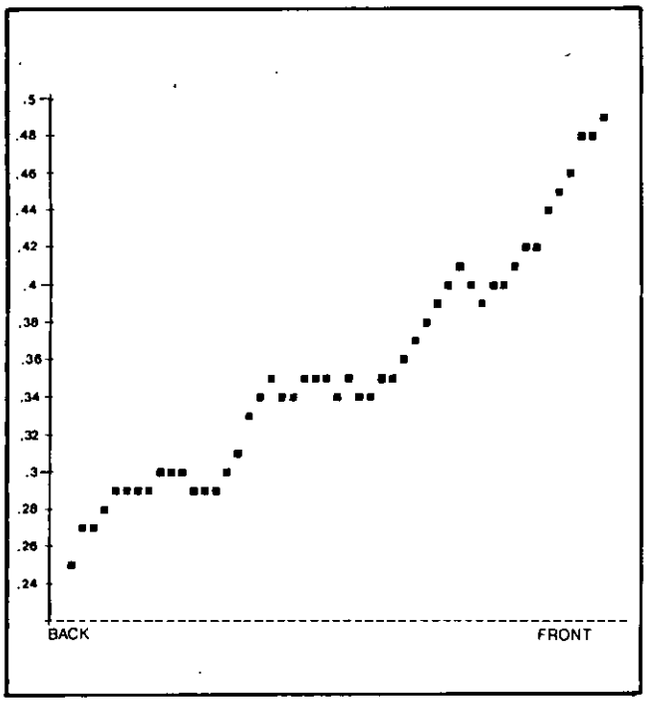


Figure 3a: Downflow profile in second Class cabinet with original front floor section.

Figure 3a shows the pattern in another Class II cabinet with a perforated floor fitted in two sections. The holes in the front section were wrongly sized, and the front half of the trace shows considerable turbulence. *Figure 3b* shows a much smoother pattern, after a new front section had been fitted.

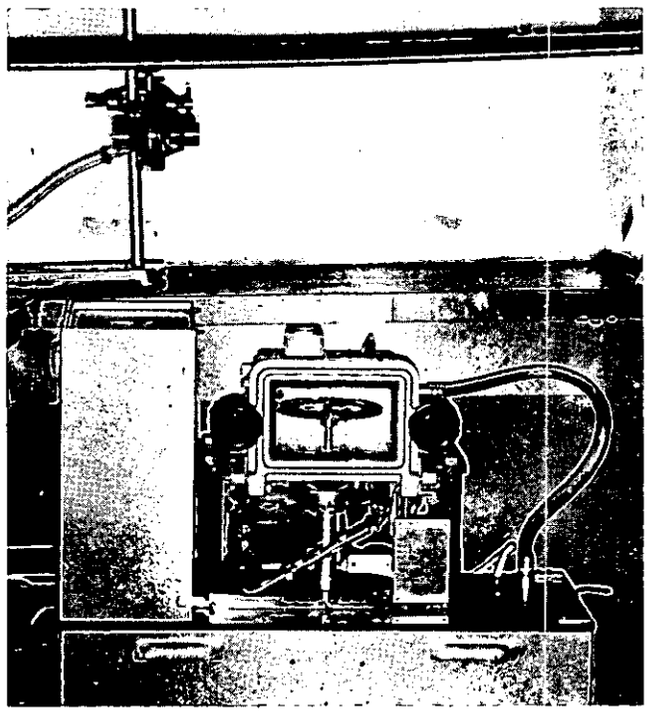
Figure 3b: Downflow profile in second Class cabinet with re-designed front floor section.



Containment tests

When I first did containment tests I used an aerosol of bacterial spores *(Bacillus subtilis var globigii)* as a simple test that relates directly to cabinet function (i.e. retention of an infective aerosol). *Figure 4* shows the test set up. A challenge of approximately 2×10^4 spores is liberated from a BIRD micronebuliser, which is powered by compressed air at 10 PSI, and pointed across the cabinet 6'' behind the front face.

Figure 4: The Spore Containment Test: Slit sampler — front centre; Nebuliser — rear left centre.



The aerosol was liberated in a 10 second burst, and any spores that leaked into the laboratory were caught by the slit sampler placed in front of the unit, with its sampling orifice at bench level, and set to sample 561 of air in 2 minutes. The slit sampler is a piece of standard laboratory equipment, and the micronebuliser (available from B.O.C.) cost around £7, and was powered by an oxygen cylinder obtained from the Anaesthetic Department.

Studies on 40+ cabinets showed that containment depended on adequate airflow through the front, and that the front opening should be unobstructed. Hand holes — for example glove ports without gloves — create turbulent streams of air within a cabinet that can deposit aerosols on its inner surfaces (including the operator's fingers).

The British Standard specifies a rather more complex containment test, in which a similar nebuliser is placed 4'' behind the working aperture, pointing forwards and no less than 10^8 spores are liberated. An 'artificial arm' is used to break the airflow, and two slit samplers are used and operated for ten minutes. The challenge dose is worked out by counting the spores in the nebuliser, and a 'protection factor', which must be $>10^6$, is worked out by relating it to the number found in the room air.

In practice, no more than 10-20 spores should be detected in the room, so that the pass rate is near the limit of detection. Makers sometimes hope for high protection factors, say $>10^7$, as sales points, without realising that this is beyond the limits of detection. Some problems have

arisen with the B.S.I. refusal to name actual equipment in the standard; thus a range of nebulisers can be used and some produce poor sprays (the *Incentinab* for example). The one we now use is sold by *Gelman*, as a calibration aid for the *Royco* air particle counter; while at Porton the *Collison Spray* is used.

The equipment required for spore testing is thus not complex, and need not be expensive. Complete sets are commercially available. As spores are readily counted, the challenge dose can be accurately quantified, and the bacterial aerosols can easily be checked for particle size. The aim is to have small particles in a 'monodisperse' aerosol, with a size of 0.3—1μ. This type of particle has the added advantage of being usable to test filter integrity.

However, while spores are easy to use, they require the services of the microbiologist rather than the engineer. Furthermore, the virologist or tissue culture scientist might not appreciate spores all over his work, so there is a need for an 'on-site' alternative. The British Standard allows for particles of under 7μ to be used, and suggests that a potassium iodide in alcohol aerosol might be effective. A commercially manufactured test system (*Ki-Discus, Watkin and Williams)* became available about a year ago. The DHSS purchased one for evaluation, but tests were considerably delayed by mechanical failures.

The aerosol is generated by dripping 1.5% potassium iodide onto a disc that rotates at 26,000 rpm, and sampled in centripetal air samplers. Particle size is stated to be 7-10μ, but in our hands up to 60% of the spray appears as 20μ particles; furthermore very small particles cannot be picked up by the sampling system. Thus the *KI* aerosol is not readily quantifiable, and by its nature is no use for filter testing. Tests in parallel with spores suggest that similar results are obtained in Class I cabinets, but some divergence has been noted with Class II. It is still too early to come to a final conclusion about the role of the *KI* discus.

We have now tested over 20 types of cabinet with the B.S. spore test and have found it works well and is certainly satisfactory as a type test. The American National Sanitation Foundation Standard relies on a very similar test.

Installation

Regrettably few newly installed units seem to live up to their specifications, and in several instances I have found units that worked satisfactorily in my test laboratory failing elsewhere. The length, diameter, sealing and geometry of the exhaust ducts cannot be predicted by the manufacturer, but all affect the airflow.

I have seen the following installation defects:

Incorrect fan size for duct length.

This is relatively common. An extreme case was in a hospital with cabinets on the third floor, which had to be exhausted through a roof vent on the fifteenth.

Incorrect duct geometry.

One cabinet had a short length of 23cm diameter ducting in the laboratory which ended, hidden above the roof, in a 4cm bore drain pipe bent through a tight 180° turn to keep the rain out.

Our own newly installed unit failed to work, despite a short run of wide-bore duct, because the latter was of a concertina-ridged metal; a replacement with smooth bore drain pipe solved the problem immediately.

Leaky duct joints.

One unit failed because the flexible ducting had been 'gathered up' to fit it to the fan flange; a large hole had been left concealed behind the duct. Also, again in Cambridge, we found an open inspection port in one of our ducts hidden in the plant room above the laboratory.

Common-duct systems.

On two occasions, I have seen units that failed to work until adjoining fume cupboards were unlinked from communal exhaust systems.

Inadequate air supply.

The standard cabinet requires around $10m^3$ ($600ft^3$) of air per minute. This may not be available with the door shut. One cabinet I tested, which was 5'' wide, was in a small room (a converted gents' toilet); the airflow doubled when the door was opened. On the other hand, air supply can be overgenerous. We recently saw a most complex room-ventilation system, almost to operating theatre standards, installed in a Category B room.

Incorrect wiring.

One animal house unit inspected lately had a UV lamp wired with the cabinet fan. The operator complained of 'arc welder's eye'.

The ideal installation is in a quiet area of room — to avoid backdraughts which are said to reach 0.85 m/sec as people walk past — situated on the top floor of the laboratory, so that the exhaust duct (smooth bore) can pass to a roof-mounted fan, with a minimum of bends and discharge on the roof through a suitably protected vent.

The basement room embedded in the core of a 15 storey building illustrates the opposite picture — a problem. The long ducts and powerful fans required may present problems, and an alternative which might be acceptable is to recirculate the exhaust air into the room through two HEPA filters, one above the other, in place of one. Certainly, if the laboratory is able to test its filters on-site regularly, this approach would be worth serious consideration.

Use of Safety Cabinets

Having obtained a suitable unit, and had it installed properly, the final problems are of use and maintenance. Firstly, the cabinet must be switched on! In one laboratory I visited, a cabinet was off although a shaker

Figure 5: Cabinet misuse!

was at work inside it. The reason: the noise in the adjoining office was too great! Next, all laboratories should have access to an anemometer and measure airflows (the *Howie Report* specifies monthly).

A convenient record can be kept on a sheet of paper stuck on the side of the filter. The filter must be changed when the flow drops below 0.75 m/sec. Most laboratories now have an anemometer and have instituted this — a sharp contrast to ten years ago. When I first visited the laboratories of our Region, virtually all had cabinets with an inadequate airflow, several due to blocked filters.

The rate at which filters and pre-filters block varies greatly with local conditions, being maximal in Central London. An important point to note is that the pre-filter (or grid in old *LEEC* units) can become dangerously loaded without altering the airflow. Excess fluff or dirt can build up to such a state, that it will drop back into the cabinet when the fan is switched off, or may be blown back by any 'blowback' down the duct. Pre-filters should be inspected regularly, and will need changing more often than airflow measurements suggest. The grids should be kept clean by wiping with disinfectant.

Sterilization of the Safety Cabinet

Effective methods are needed for sterilization of the safety cabinet. The methods commonly used have been short wave (2537A°) ultraviolet irradiation, formaldehyde or glutaraldehyde. Most old cabinets were fitted with a UV lamp, and some had an optional formalin vaporizer.

Published work on ultraviolet rays deals mainly with wet microbes in fluids or aerosols. The rays are undoubtedly bactericidal, although bacteria vary in susceptibility, and tubercle bacilli are relatively resistant. However, removal of bacteria in aerosols inside the cabinet is a function of the filters. The bacteria remaining on surfaces are likely to be dry and protected by protein, as in dried spit. The value of ultraviolet under such circumstances is questionable.

The Table shown below gives the results of an experiment to demonstrate this point. Various numbers of cells of *Mycobacterium phlei* (a relative of the tubercle bacillus) were dried from water on to strips of aluminium foil and exposed, inside a cabinet, to 50 $\mu w/cm_2$ of irradiation for different times. The strips were exposed in sets of four, and the numbers in the Table indicate those in each set that contained viable bacteria after exposure. Thus, to get a reliable kill of 1,000 cells took 8 hours and 10,000 cells required 24 hours. Such times are inconsistent with normal cabinet use.

RESISTANCE OF Myco. Phlei to U.V. Radiation (50 μw / cm^2)

No. of Cells	EXPOSURE IN HOURS 0	1	2	4	8	24
10^5	4	4	4	4	4	4
10^4	4	4	4	4	3	0
10^3	4	2	4	3	0	0
10^2	4	1	2	0	0	0
10^1	0	0	0	0	0	0

Number • Test strips (out of 4) with surviving bacteria

Table 1.

Furthermore, UV presents other problems. The bacteria may lie in the shadow of equipment or cabinet fixtures; UV tubes soon become dirty and inefficient, and anyway lose viability after 1,000 hours (only measurable with a time clock). An outdated tube emits visible light, as does a long-wavelength bulb, even though neither is producing bactericidal rays.

The long-wavelength tube looks similar to, and fits the same lamp holders as, the germicidal tube. We discovered this when first trying out our UV meter; our electrician had inadvertantly fitted the wrong replacement. Thus, use of UV is seen to be of marginal value and, unless needed for special experiments, is best omitted from the cabinet specification — or a false sense of security can be engendered.

Glutaraldehyde was recommended because, unlike formaldehyde, it does not polymerise and so avoids unpleasant deposits on cabinet surfaces and contents. However, I found that boiling-off 10ml/0.028m^3 space inside a cabinet failed to kill spores, although the surfaces were wet with condensed glutaraldehyde. The smell made my laboratory uninhabitable for 48 hours.

Formaldehyde gas is the best agent for sterilisation of cabinet surfaces, and it will decontaminate the surfaces of filters sufficiently for safe filter changing, although it cannot be expected to penetrate into the filter and render it totally sterile. However, the gas must be used correctly; several previous official recommendations are no longer tenable, viz:-

Expose a bowl of formalin inside the cabinet for 18 hours: Result — inadequate concentration.

Boil 100ml formalin with the fan running: Result — rapid dispersal of gas, so cabinet surfaces are not touched; but the filter may block with polymerised formalin.

Set off a *Laycocks fumigator* inside the cabinet: Result — certain to work but, as said to be designed for 28m^3 room, overkill for a 0.38m^3 cabinet. Regular use will block filters.

Two methods can be recommended:

Seal the cabinet; slowly evaporate 2ml formalin/0.028m^3 of space (say 20 minutes), then leave for 18 hours.

Depolymerise 0.3g paraformaldehyde/0.028m^3 and leave for 18 hours. Depolymerisation can be achieved with flakes and an electric frying pan, or tablets and a heat gun. The latter, available from *Laboratory and Thermal Electric*, Greenfield, has the advantage of circulating the gas and of heating the whole cabinet. Some moisture must be added, for example in a small cube of wet foam rubber, and the cabinet again is left for 18 hours.

Conclusion

Proper awareness of the hazards of aerosols, and use of codes of practice such as the *Howie Report* — together with the availability of suitable safety cabinets, are going a long way towards improving laboratory safety. Indeed, two on-going surveys of laboratory-acquired infections are showing a pleasing decrease in incidence, which it is hoped will be maintained, if not improved upon.

Achnowledgement

This work has been sponsored by the DHSS Engineering Division, to whom I am most grateful.

The author is the District Engineer for the Portsmouth and South East Hampshire Health District.

Gas Scavenging at Queen Alexandra Hospital Portsmouth

E C BOYLAND CEng MIEE MIHospE

Introduction

Because of the increasing concern over the possible long term effects of prolonged exposure to trace amounts of anaesthetic gases, it was decided to check the effectiveness of the ventilation and gas scavenging systems in one of the operating theatres and the recovery room at Queen Alexandra Hospital by carrying out continuous monitoring of the atmosphere during operating sessions.

The Public Analyst had previously indicated that he would be in a position to carry out tests to the standard required by the Works and the Anaesthetic Departments.

A meeting was ultimately arranged between Works staff, representatives of the Public Analyst and the Anaesthetic Department during which arrangements were made to:-

(i) Provide facilities for the PA staff and decide on scale of tests within the funds available.

(ii) Ensure that the monitoring positions within the theatre and recovery room were to the satisfaction of the Anaesthetist, who would also act as co-ordinator/observer during the periods of monitoring.

Each investigation covered a normal working day ie from approximately 09.00 hours until 17.00 hours.

It was recognised that contamination could exist due to one or more of the following reasons:-

(i) bad fitting of patient's mask

(ii) release into the atmosphere during changes in the application of anaesthetic gases

(iii) leaks on anaesthetic machines or ventilators

(iv) exhalations by patient

(v) general ineffectiveness of gas scavenging systems.

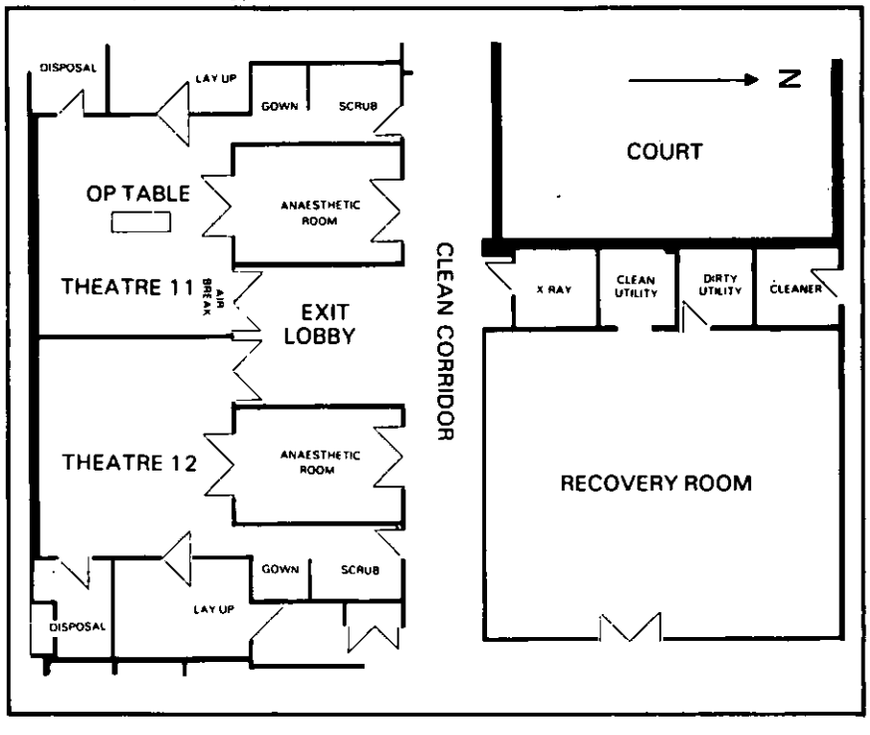
The Equipment

The equipment used was the Miran 1A, a variable path length recording infra-red spectrometer of adjustable wavelength. The recorder was temporarily mounted on a theatre trolley. The instrument was adjusted to read from 0.1 micrograms per millilitre to 600 micrograms per millilitre (nitrous oxide) and from 0.1 micrograms per millilitre to 6 micrograms per millilitre (halothane). The response time for recording purposes was approximately 4 seconds.

The units used throughout the report are micrograms per millilitre equivalent to parts per million (PPM) weight in volume.

When adjusted to high gain, there was a possibility of slight interference to the nitrous oxide readings from carbon dioxide and water vapour. Although this would have accounted for some minor irregularities, it would not have affected the significance of the results.

Figure 1: Layout of Operating Theatre



The equipment was set up by PA staff at the start of the operating session and left running unattended throughout the day with the anaesthetist repositioning as desired and recording the event at the appropriate position on the chart.

Existing Conditions

The theatre chosen was one of a suite of seven theatres situated on Level E of the Hospital complex.

The theatre is fully air conditioned with 20 changes of open air per hour. Two air supplies enter the theatre at high level and are exhausted at low level via pressure relief dampers and vents in the doors of adjacent rooms.

The recovery area is situated immediately opposite the theatre ancillary rooms with the access via an open corridor at right angles to the clean corridor. Ventilation of the recovery room is achieved by means of an air supply and exhaust system at ceiling level.

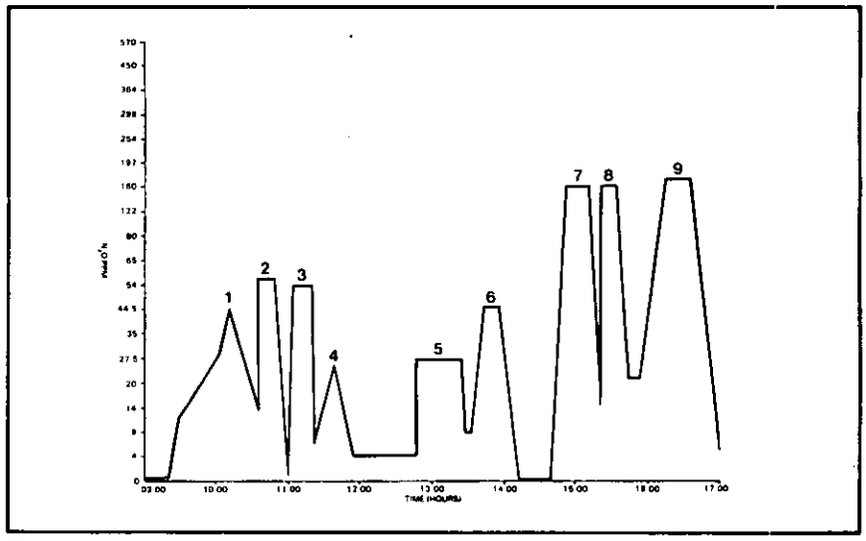
Each theatre is fitted with an assisted passive gas scavenging system which comprises a direct discharge through 35mm tubing from the patient to the trunking of the extract system. An air break is fitted in the pipework 4 ft. below the point of discharge to the exhaust trunking and immediately above the connector for the flexible tubing. Apart from the positive pressure produced by the exhalation of the patient, and the ventilation system, there is no other assistance in discharging the gases to the exhaust trunking.

The intention of the air break is to prevent a positive or negative pressure building up due to a malfunction of the scavenging system.

This type of assisted passive system is believed to be common to many installations fitted in new and upgraded hospitals throughout the country. It is because of its widespread use that the results of the tests are particularly significant.

The Results

The results obtained are in the form of graphs, and as it was not possible to present the graphs in their original form, it was decided to average the results over the 8-hour period and draw attention to the more important features. Comments regarding the movement of the probe, removal of face mask and other clinical functions, were added to the original graphs by the anaesthetist supervising the recordings.



Graph 1

Graph 1 - Nitrous Oxide Theatre

This graph was obtained with the theatre functioning in its normal mode with the air break of the scavenging system operating 'as fitted'. It is apparent that the atmosphere in the theatre was badly polluted with waste N_2O during the whole of the operation. Because of the 'averaging' of the results, the peaks of the pollution are not shown, but from the original graph, it can be shown that levels of pollution in excess of 570 ppm occurred on 18 occasions. Although these high values were recorded they do not necessarily relate to the intake by theatre personnel, but it is reasonable to assume that the staff were subjected to high levels of polluted air for considerable periods throughout the day.

Short term minute-to-minute variations (not shown on the averaging graph, but clearly recorded on the original) may relate to the movement of personnel, as these were less noticeable in a depopulated situation.

The reasons for the peak values are given as follows:-

Peaks 1 & 2 — There is no apparent explanation for these peaks but they were probably due to movement of staff or opening of doors. A small peak (65 ppm) of short duration (not shown) was attributed to the breathing of the patient near the probe at the completion of the operation. The position of the probe for peaks 1 & 2 was on the west wall (*Graph 1*), and the maximum peak for this period was 150 ppm.

Peak 3 — Caused by accidental disconnection of scavenging system. Maximum peak 65 ppm.

Peak 4 — Mask removed and airway in. The maximum peak during this period was 45 ppm.

Peak 5 — During this period, the probe was positioned close to the extract valve on the anaesthetic machine, and the maximum value recorded was 'off scale' of 570 ppm. This occurred during the accidental disconnection of the scavenging system.

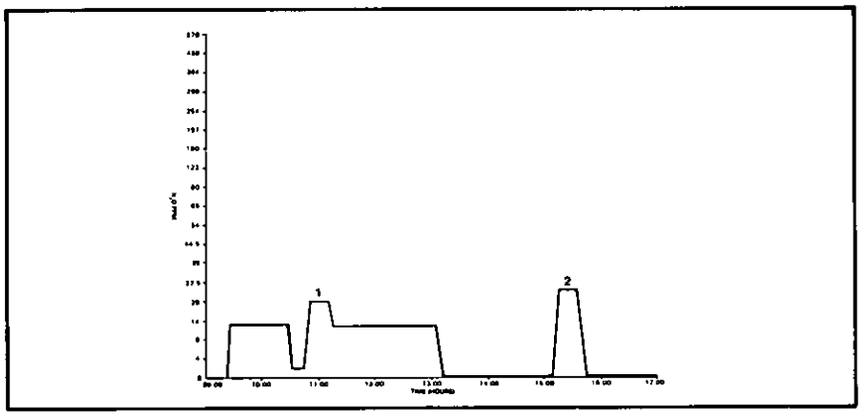
Peak 6 — The probe was returned to the wall during this period and two peaks of 120 ppm were recorded.

Peaks 7, 8 & 9 — For these periods, the probe was positioned approx. 1 in. below the air break ie at approx. 6 ft. above the floor. A number of peaks occurred during these periods 'off-scale' at 570 ppm giving a total pollution time, at that level, of approximately 20 minutes.

(It is interesting to note that the original graph indicated a rise in N_2O level from 0 to 10 ppm during the lunchbreak when the theatre was unoccupied and the N_2O supplies turned off. The reason for this is not apparent.

Graph 2 - Theatre Nitrous Oxide

Because of the high values of pollution in the area adjacent to the air break (attributed to loss of pressure within the theatre and re-entry of polluted air) it was decided to seal the air break and repeat the tests. The significant effect of this action on the quality of air within the theatre is clearly shown on the graph. For this test, the probe was positioned on the west wall approximately 4 ft. from the floor..



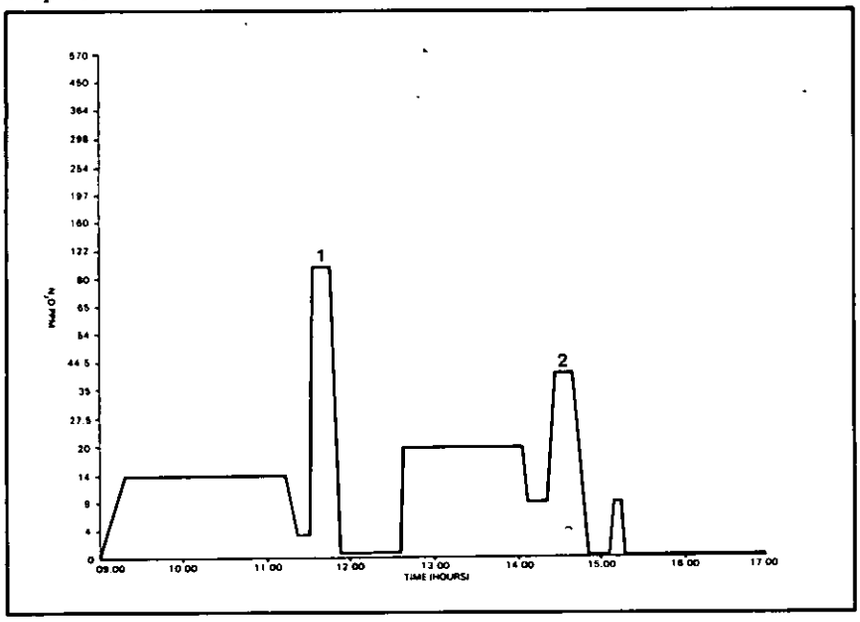
Graph 2

Peak 1 — The peak was attributed by the anaesthetist to the scavenging system being accidentally disconnected. A maximum value of 50 ppm was reached during this period.
Peak 2 — This was explained as a badly fitting mask. A maximum value of 80 ppm was recorded for approx. 30 seconds. It can be seen that an average value of approximately 10 ppm was recorded for the whole of the operating period.

Graph 3 - Theatre Nitrous Oxide

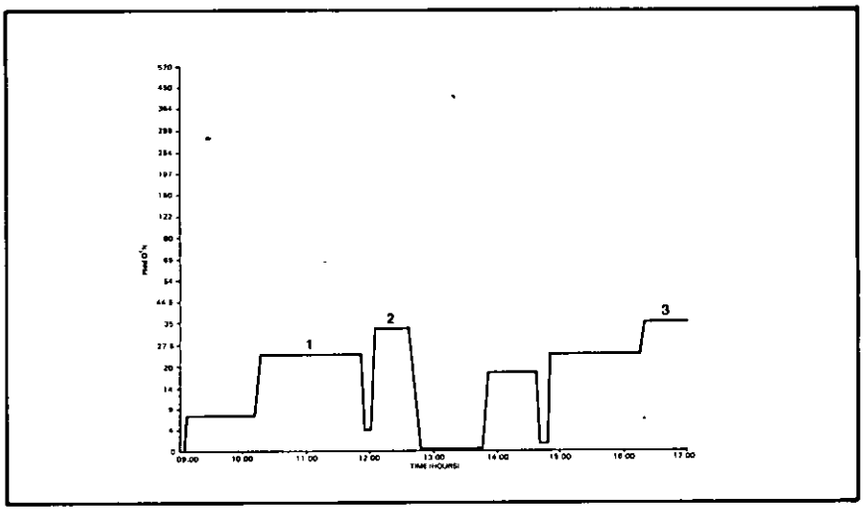
This recording was made with the probe in the same position as for graphs 1 & 2, but with the air break sealed. Peak 1 was obtained when the probe was held close to the expiratory valve on the anaesthetic machine. A maximum value of 360 ppm was recorded during this period. Peak 2 was explained as a badly fitting face mask.

Graph 3



Graph 4 - Theatre Nitrous Oxide

The air break remained sealed for this recording (as in graphs 2 & 3). The sensor was placed 2 ft. from the head of the patient and near to the position normally taken up by the anaesthetist. A steady low level was obtained until approximately 10.12 when a change in anaesthetic procedure raised the level to an average 24 ppm (peak 1) with a maximum peak of 34 ppm (peak 2). The pattern was repeated during the afternoon session. The average pollution throughout the day was approximately 20 ppm.



Graph 4

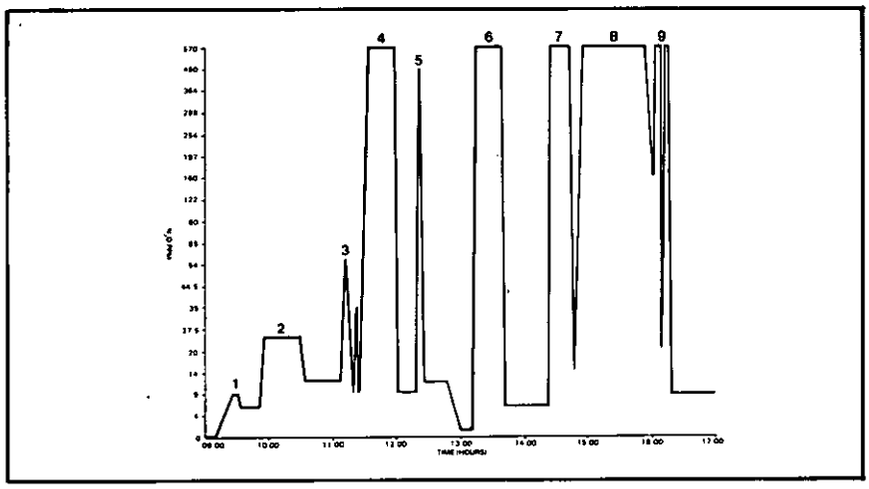
It can be clearly seen that the average value of pollution and the staff exposure time is greatly reduced with the scavenging system operating with the air break sealed.

Graph 5 - Recover Room Nitrous Oxide

This recording was made with the probe positioned between the patient's head and the nurse in attendance. It is interesting to note that a level of pollution of 10 ppm occurred before a patient was admitted, which can only be explained by air entering the room from one of the theatres where a patient had been anaesthetised.

The high values indicated by peaks 4, 6, 7, 8 and 9 were recorded with the pen off scale at 600 ppm, giving a staff exposure time of 3 hours at that level. As with previous graphs, it is interesting to note how quickly a build-up in pollution occurs when a patient is brought into the room and the corresponding decay as the last patient is returned to the ward.

The original recording is well documented, and gives types of surgery carried out, time patients were admitted and details of nursing functions. The higher exposure time in the afternoon is almost certainly due to the increase in the number of patients under observation.



Graph 5

Graph 6 – Recover Room Halothane

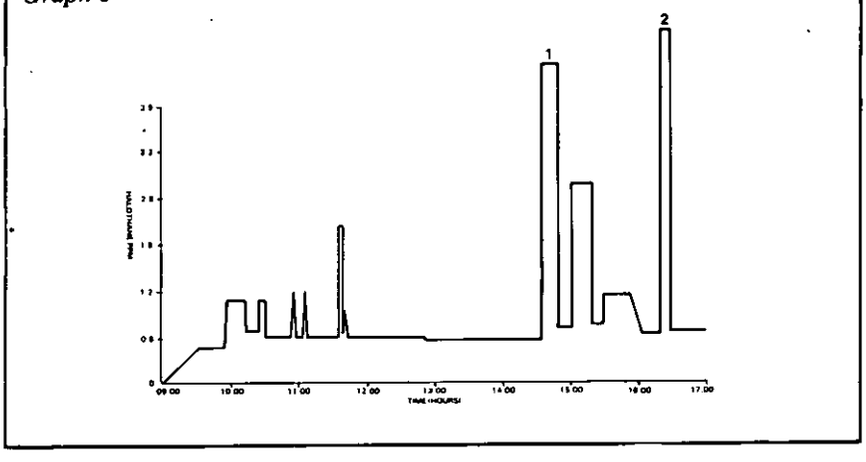
The original recording indicated a level of pollution of 0.3 ppm before a patient was admitted and (as in graph 5) can only be attributed to patients being anaesthetised in the theatre suite. The average level of pollution until 14.30 hours was approximately 0.9 ppm but higher values occurred later giving an average of 2.0 ppm.

The maximum values recorded during peaks 1 and 2 was off scale at 5.8 ppm giving a staff exposure time of approx. 10 minutes at that value. As would be expected, the values of halothane pollution were compatible with the recording obtained for nitrous oxide pollution (graph 5).

Assisted passive systems where waste gases are discharged into exhaust systems can be ineffective if fitted with an air break within the theatre, and this is clearly demonstrated by comparing the results shown on graph 1 with those on graph 2 when the air break is sealed. Conversely, it is apparent that simple passive systems with the mode of operation as described can be extremely effective in keeping the pollution within the limits laid down by the DHSS.

Notwithstanding the movement of air created by the ventilation system, it is concluded that the movement of staff within the theatre and the opening of doors have a significant effect on the levels of pollution within the theatre. This aspect is perhaps more important when considering the ventilation or the fitting of scavenging systems in recovery rooms, where the air changes per hour are considerably less.

Graph 6



Conclusions

There are a number of important conclusions to be drawn from the results of the tests and they can be summarised as follows:—

The reason for the excessive pollution in the vicinity of the air break, which in the situation described is in a vulnerable position as far as the staff are concerned, is not clear but it is assumed to be due to one or more of the following reasons:-

(i) Poor pressure differential between the theatre and the exhaust trunking.
(ii) Disturbance of air flow around air break due to movement of staff and/or opening of theatre doors.
(iii) Design of air break which allows gas to flow back into the theatre under the conditions described in (i) or (ii).
(iv) Method (or position) or entry of scavenging pipework into exhaust trunking.

The high level of pollution in the recovery room confirms all that has been said and written about the risk to staff in this particular area, and the consistently high values will continue to present a greater risk, compared with the theatre, until an efficient means of scavenging is provided.

The levels of pollution recorded do not necessarily relate to the intake by medical staff. These may be greater or less according to the air turbulence within the rooms. It must also be borne in mind that both nitrous oxide and halothane are heavier than air and assume a higher temperature when exhaled by the patient. This has the effect of the gases rising when exhaled and falling as cooling takes place, and this could be a contributory factor to the gas escaping from the air break.

It must be stated that the air break was sealed on an experimental basis with the full agreement of the anaesthetist, to establish if a poor differential existed between the theatre and the extract trunking, and the effect it would have in reducing the pollution in the immediate vicinity of the air break. It was a temporary measure only, and cannot be regarded as a solution to pollution problems, regardless of the circumstances prevailing in the theatres at that time, due to the hazard it may present to the patient.

Acknowledgements

The following assisted in the tests and the preparation of the report:
Mr. K. Andrews, Sector Engineer, Northern Sector.
Mr. Johnson, Public Analyst Department, Portsmouth.
Dr. J. Moon, Anaesthetic Department, Queen Alexandra Hospital.

Audio-Visual Review

Energy Conservation in Hospitals

by Camera Talks Limited, 31 North Row (Park Lane), London W1R 2EN

Audio-visual material is being produced in an ever-increasing number of subjects. This is one of the first packages available in our field. It deals with energy conservation in hospitals.

The presentation is in two parts, the first is aimed at the technical personnel and the second is meant for the non-technical disciplines.

The package comprises 35mm colour slides and pre-recorded commentaries on cassette tapes, together with a script.

Part one for technical personnel contains 41 slides (including title and credit slides) and part two contains 27 slides.

The benefit of an audio visual presentation is that the audience perhaps retain more facts than they would by just the spoken word or by hand-outs which tend to become mislaid or filed 'for future retrieval'.

Unfortunately, much of the material used is very basic and it is hoped that any technical personnel, be it tradesman or supervising engineer, who works with hospital plant, will be only too familiar with the guidance offered by this package.

When one considers that many pages can be written on just one aspect of energy conservation, then for Camera Talks Limited to attempt to summarise the whole field of energy conservation in hospitals on forty odd colour slides the brevity and statement of the obvious must be accepted.

Part One of this presentation could prove useful to new entrants such as apprentices, or technical personnel recruited from the private sector and could be considered as a 'refresher' on the subject for tradesmen.

Part Two uses many of the slides contained in Part One but this part of the package for non-technical personnel does have more to offer and can be a 'tool' to enlighten other disciplines on the problems of energy wastage and perhaps even win them over to your way of thinking.

It will probably be an extremely useful presentation for newly recruited nurses and established staffs who have come to take energy for granted, in particular, catering staff, laundry personnel etc.

This presentation then does not set out to provide magical or revolutionary solutions to energy wastage. It is intended as a reminder as to what steps should be taken by both technical and non-technical personnel.

Camera Talks Limited have attempted to provide the Engineer with a professionally produced package to enable him to visually present to his own staff and energy users simple facts and easily implemented measures which can only help to reduce or at least contain energy consumptions.

This company has a long pedigree of audio-visual productions covering Bacteriology and Microbiology, Care of the Aged, Crime Prevention, Environmental Health, Family Planning Methods, First Aid and other subjects related to health, nursing, safety, education etc.

The cost of the package (slides and cassettes) is;

Slide Sets in boxes £14.95 per part.
or Slide sets in Album Pages £16.9 per part.
or Slide Sets in Cabinet Files £16.95 per part.
Cassetted Tape Commentaries (impulsed) £8.95 per part.
Printed Commentaries £0.95 per part.

These should be ordered from Camera Talks Limited and NOT from *Hospital Engineering.*

Product News

Transportable Category B Work Area

Equipment and techniques to reduce the risk of aerosol inhalation of pathogenic micro-organisms were prominent in the Code of Practice for the Prevention of Infection in Clinical Laboratories and Post-Mortem Rooms (HMSO London 1978), often known as the Howie Code of Practice. As a result, many laboratory facilities have been improved, often involving expensive and disruptive building and engineering work. However, in other laboratories, limitations of the existing buildings virtually preclude such work. For these particularly difficult situations, Envair (UK) Limited has designed the Transportable Category B Work Area, which is a small factory-built laboratory housed in a transportable building, delivered to site by road and ready for occupation almost immediately.

As far as possible, the design embodies the recommendations of the Howie Code, as well as providing for the comfort of the laboratory staff, minimising disruption to normal work during installation and allowing for easy maintenance subsequently.

The structure is an insulated and air-conditioned transportable building, within which the actual work area measures 2.7m by 5.4m with a minimum height of 2.4m. This area is maintained at a slight negative air pressure by the air conditioning unit which allows for 18 air changes hourly and maintains the temperature of the work area at 20°C. Access is through a changing area measuring 2.7m by 1.8m. All extract air passes through a HEPA filter.

Daylight in the work area is provided by two windows in a side wall; there are two fluorescent overhead light fittings. The area is equipped with benches, cupboards and drawers, and a laboratory sink unit. At the far end of the work area is a Class I microbiological safety cabinet, complying with BS 5726 and exhausting above roof level after filtration. At the other end of the room is a wash handbasin with wrist/elbow operated taps, plus paper towel dispenser and pedal bin.

The changing area is lit by a window into the work area and by a ceiling-mounted flourescent light fitting. There is a cupboard and drawer unit under the window and there are lockers for personal belongings and hooks for protective

clothing. The air conditioning unit and electrical switchgear are also installed in this area.

The building weighs about four tons and its prefabricated lattice steel support framework rests on four concrete pads. The structure is designed in accordance with Building Code of Practice 112:1967, Use of Timber in Buildings. All voids in the construction of the floor, walls and roof are filled with glass fibre thermal insulating quilt. Windows have maintenance-free extruded aluminium frames. All wiring is in accordance with IEE regulations.

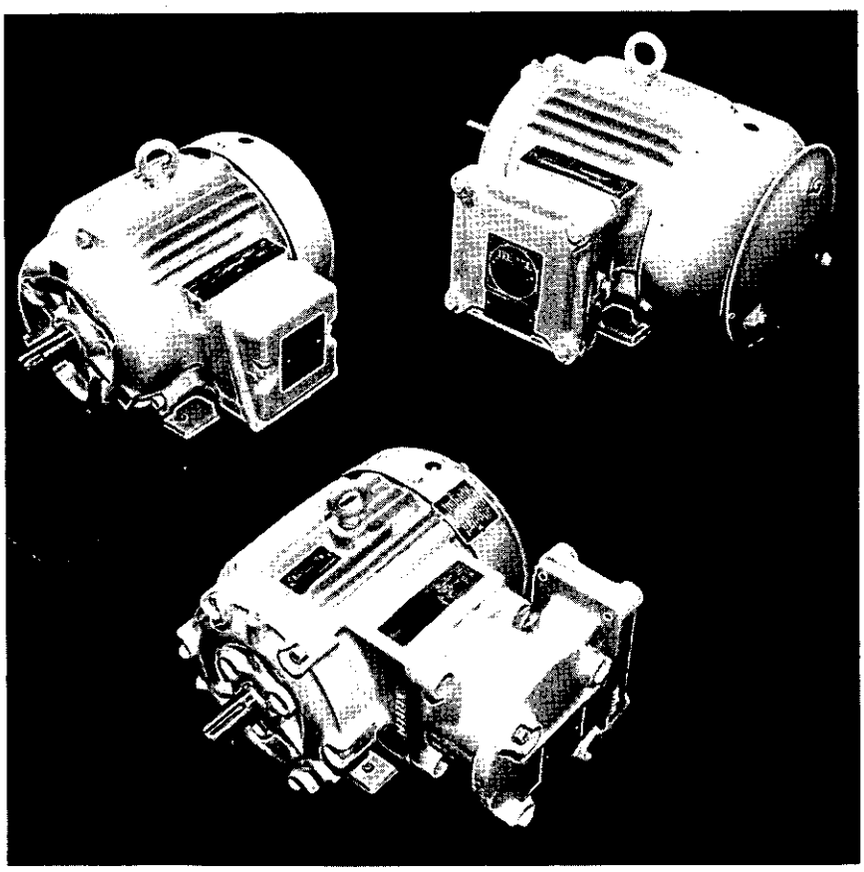
Further details are available from Envair (UK) Limited, York Avenue, Haslingden, Rossendale, Lancashire, BB4 4HX, telephone 0706 228416.

Condensate Recovery Units

The Girdlestone Condensate Recovery Unit is the subject of a new four-page full colour publication (Ref. 3G 4/81) now available from Spirax Sarco Limited, Cheltenham.

This new publication contains technical specifications, operating parameters, formulae for calculating potential savings and information relevant to the design of the equipment.

For further information about and copies of this brochure, please write to: Spirax Sarco Limited, Charlton House, Cheltenham, Gloucestershire, GL53 8ER.



High Reliability Electric Motors

The three new classes of 'Hi-Seal' motors from Newman Electric Motors of Bristol are shown in the above picture: left, the GP Type for arduous duty in non-explosive harsh environments, the ExN-OCMA, right, for semi-hazardous zone 2 areas and the Exd flameproof, front, intended for high-risk zone 1 locations. Each of the new high specification Hi-Seal motors offers a two-year guarantee, weatherproofing to IP55, 'chemical area' finish and special grease-relief facilities as standard.

The new Hi-Seal 'package' is said to offer price reductions, improved specifications, higher performance capabilities, extended guarantees and faster delivery.

For details contact: Newman Electric Motors Ltd, Station Road, Yate, Bristol. BS17 5HG. Tel: 0454 313311.

Timber Building Rescued

Disbotherm System 600 has been used to insulate an old timber building at St. Margaret's Hospital, Epping, so that it can be used to accommodate elderly patients.

Built in 1940, the building fell into disuse in the cold winter of 1978/79 because of the cost of heating it. The timber-framed structure had an internal lining of composition board, the external face was covered in bitumen sandwich building paper and overclad with painted weatherboarding. Considerable heat loss through the walls meant that not only was the building very expensive to heat but in cold weather it was not possible to lift the temperature to a comfortable level.

The Essex Area Health Authority did not want to demolish the building because the frame and roof were sound and the electric, plumbing and other services were in good order; to replace it with a permanent type structure would have been prohibitively expensive.

The timber cladding and the bitumen sandwich paper was stripped and the entire external area was weatherproofed and re-covered with 12mm. exterior quality marine ply painted with aluminium primer. It then involved covering the exterior wall area with 60mm thick expanded polystyrene panels, bonded to the plywood by adhesive, and a mechanical fixing with a patented dowel. This was then covered by an adhesive render into which was embedded an open-weave woven glass-fibre membrane. This will permit movements within the building without causing damage to the insulating jacket.

External corners and edges round doors and windows were reinforced by metal edging strips before the whole area was coated with two coats of render and finished with a coloured rough stone finish. This provides a weatherproof, maintenance free finish which does not need to be redecorated and can be cleaned easily by hosing down.

Ray Collins, the Area Building Officer for the Authority, who is himself an Architect, says the treatment has been completely successful. He says it is now possible to heat the building to the required temperatures and fuel costs have been cut considerably. It has also extended the life of an otherwise uneconomic

building and very considerably reduced maintenance costs.

Disbotherm Limited is based at 12 Mount Ephraim Road, Tunbridge Wells. Kent. Telephone: (0892) 22491.

Total Heat Recovery Package

Since the launch two years ago of the Dantherm XVV 25/130 range of packaged plate type heat recuperator, Dantherm have further developed the concept by adding a heat pump after the plate exchanger making it possible to recover up to 100% of waste heat at a low operating cost. Pay back periods of less than two years made air to air heat recovery a financially viable proposition.

The principle of the new range, designated XVV 11/44, is to recover up to 70% of waste heat using a plate type exchanger. The remaining heat is extracted by the heat pump which is fitted so that even the heat generated by the compressor is re-used.

Because the greater proportion of heat is recovered by the plate exchanger the heat pump can be fairly small, in fact about 40% of the capacity of a comparable heat pump designed to recover all of the heat. This reduces the initial capital investment and the running cost.

The new XVV package offers other new features. The heat pump is fitted with an electronic de-frosting control which automatically prevents icing up of the coil. The plate exchanger now included is Dantherm's revolutionary new modular unit consisting of standard size modules housed in a unique self-sealing frame.

The standard package can be made up from one to sixteen modules giving air capacities of 2000 m^3/h to 14000 m^3/h at inlet temperatures up to 100°C. The modules are easily removed, without the use of special tools, and are light enough for one man to handle and clean.

The cabinet has been designed to give the facility of a wide range of different specification. The basic cabinet with modular exchangers will be able to accomodate bag filters, electric or water heating coils, heat pump and eliminator plates for high humidity conditions. A matching fan section houses the inlet and exhaust fans.

Further information: Westwarm, Unit 6 Hither Green Trading Estate, Clevedon, Avon BS21 6XT. Tel: (0272) 876851

Self-contained Gas Brazing and Cutting Set

C S Milne Limited, has announced a new self-contained brazing and cutting set. Known as the STARCUT, this lightweight set gives the mobility to the operator in getting to awkward places with restricted access, without the necessity of long lengths of hose coming from standard gas cylinders. Work can be carried out in-situ using one operator, hence saving Time and Money.

STARCUT weights only 11 kg and has a cutting capacity of up to 12 mm thick plate and a brazing capacity of up to 6mm. It is also ideal for fine wire brazing and silver soldering. Butane, which is suppled from specially strengthened disposable 300 gram cartridges, is used as the fuel gas, but other gases can be used. The oxygen is suppled from an approved aluminium high pressure cylinder (H.O.A.L.4) with a capacity of 630 litres at 200 bar. Both cylinders are contained in a carrying frame with integral stand. A detachable oxygen regulator and pressure gauge is fitted and this can be easily removed for overhaul when necessary. Non-return valves are fitted to both the gas lines to prevent any back-flow. Twin heavy duty industrial gas hose manufactured to BS5120 has been used as this keeps the trailiing hose neater and less likely to kink or curl.

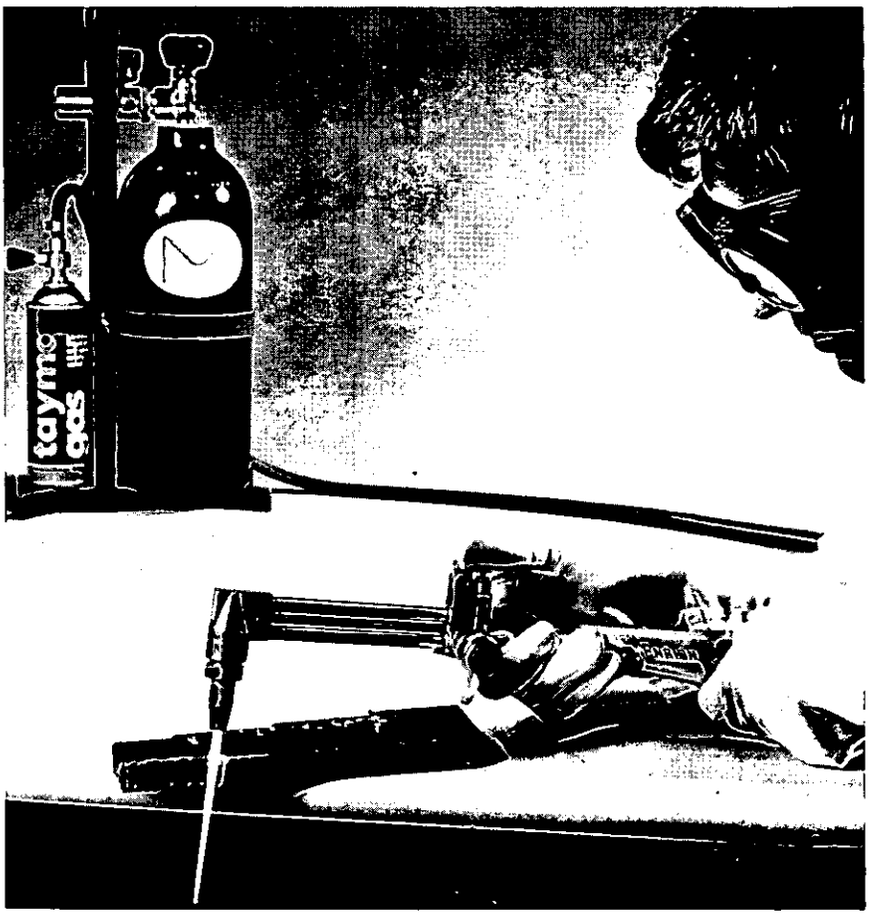
Starcut is equipped with the tried and tested Ensigh hand-held blow-pipe which has been adapted for use with butane, propane, apachi and natural gas. Three various sized nozzles are supplied with the blow-pipe. The cutting attachment for use with the *Ensign* is equipped with one PNM cutting nozzle.

The small physical dimensions of the set (total height 510 mm) means that very little space will be taken up in service vehicles in comparison with carrying standard cylinders. It will also be unnecessary for assistance to man-handle the equipment into a suitable position.

This equipment is a Life Support Design.

Details of nationwide distributor network are available from C S Milne Limited, Peckleton Common, Earl Shilton, Leicester. Telephone Number (045 572569.

The Starcut cutting and brazing set.



New Ni-Cad Cells

A 25% increase in high rate discharge performance is being claimed for a new ultra-high performance vented nickel cadmium cell announced by Chloride Alcad Limited of Redditch.

Designed for industrial high performance duties such as diesel engine starting, switch closing and uninterruptible power supplies, the new UHP/UHS range of cells is the result of extensive research and development by the Chloride Company.

The performance has been achieved by new plate design and production methods. The resulting improvements can be judged by direct comparison with Alcad's previous high performance DL range which had become an industry standard in the UK. For a given duty the new UHP/UHS cell will be 45% lighter and will occupy only half the space.

The new range is designed for any application demanding high discharge currents over periods of from one second to 30 minutes — including diesel engine starting for emergency power, switch closing and UPS systems where the battery is required to discharge rapidly over very short periods.

The Chloride Alcad UHP/UHS range is available either in polypropylene cases, or steel cases coated in a protective non-corrosive finish. The polypropylene UHP cells are available in capacities from 10 Ah to 235 Ah, the UHS (steel cased) cells from 20 Ah to 789 Ah.

Chloride Alcad is Britain's largest producer of industrial nickel cadmium batteries. The new range will complement existing cells designed for a wide range of applications from emergency lighting and alarm systems, general standby power duties and rigorous cycling applications found on mass transit transport systems.

For information: Marketing Services Dept., Chloride Alcad Ltd, Union Street, Redditch, Worcs. Tel: (0527) 62351.

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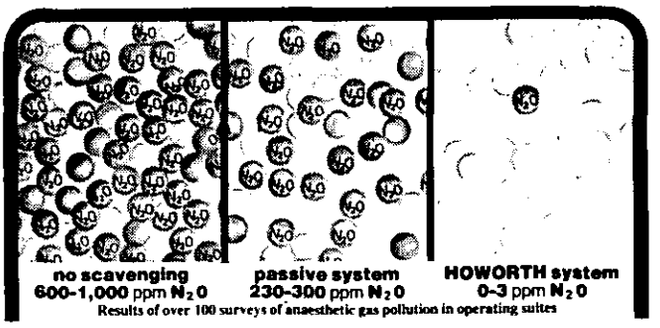

Results of over 100 surveys of anaesthetic gas pollution in operating suites

Active Scavenging of Anaesthetic Gases by Howorth

VERSATILE - the system can scavenge simultaneously up to six anaesthetic machine points or up to four recovery room points or a combination of machine and recovery room points. Adaptable for use in operating theatres, induction and recovery rooms, dental clinics, maternity units - in fact anywhere with possible pollution by N_2O.

SAFE - high volume, low pressure characteristics ensure high dilution of gases and moisture - no explosion risk, no condensation.
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EFFICIENT - an active system specifically designed to reduce air pollution by anaesthetic gases to well below the maximum levels recommended by the D.H.S.S. Effective under all conditions of pipe runs and outside wind pressures.

HOWORTH SERVICE - we offer a full survey of N_2O pollution before and after installation of our system in operating theatres and recovery rooms - we provide a recommended system layout, drawings and quotations against scale drawings and/or site visits - we will install, test and commission - we offer a six month warranty on all parts.

HOWORTH AIR ENGINEERING

Write for full details of the Howorth system or request a survey
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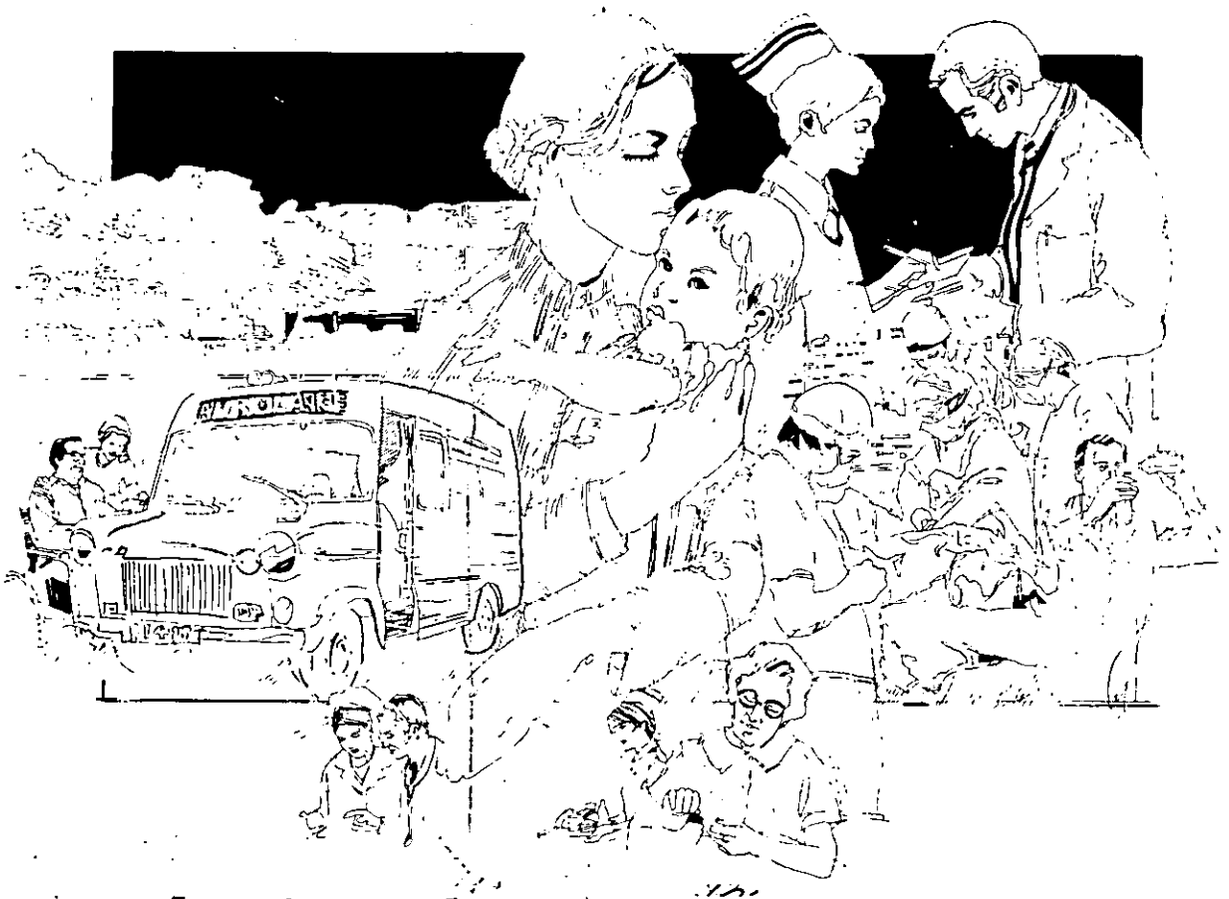
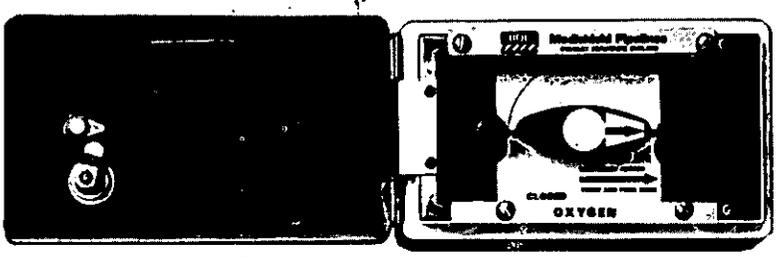


Introducing the Zone Service Unit.

The Zone Service Unit has been designed and developed by BOC Medishield Pipelines, to comply with DHSS and International Standards principles to provide a new, safe medical gas and vacuum service isolation valve and incorporates NIST connections to facilitate such important operational needs as gas sampling, gas purging, emergency access and gas isolation and an emergency supply point for high dependency areas.

The ZSU complies fully with HTM 22 and with British Standard specification BS 5682 1978 and BOC Medishield Pipelines have laid great stress in the design of the ZSU to include many special safety features, some of them unique.



Rapid emergency access without the need to break glass, non-interchangeable gas specific door assemblies, pipe blanking facility and self sealing valve incorporated in the NIST connections.

Further, the ZSU may be surface mounted or concealed within a wall, is lockable to deter unauthorised use and offers a choice of pipe entry positions to suit all installation situations.

For further information or technical advice about the new Zone Service Unit, please contact your nearest regional office or Staveley head office.

BOC Medishield Pipelines
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Staveley
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Telephone 0246 474242

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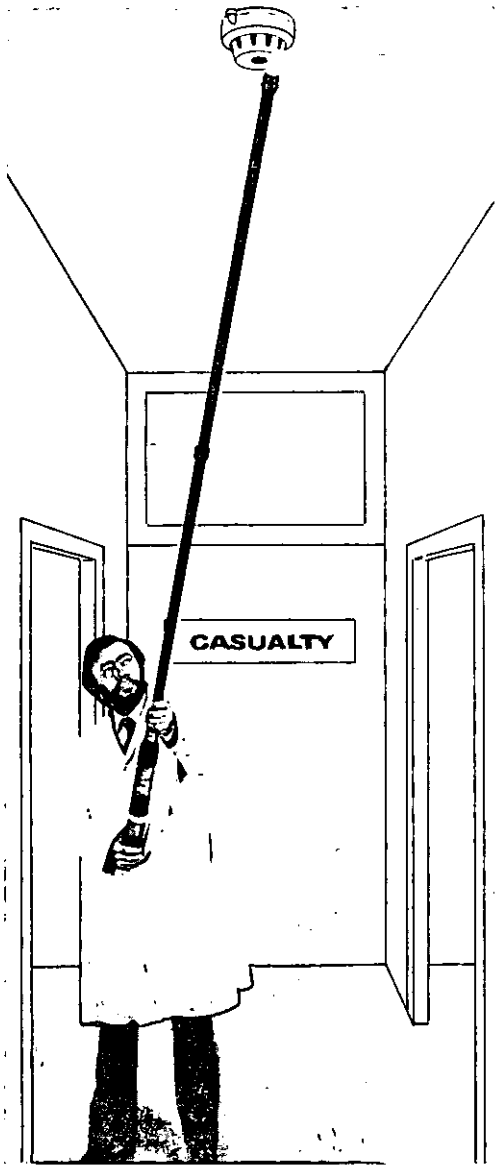


THE HAKUTO SMOKE POLE

The TSE-A100 Smoke Pole has been developed from extensive research and is designed to make the testing in situ of smoke detectors a simple and time saving operation, designed for easy, fast and efficient testing in premises where maintenance engineers are required to test fire alarm systems regularly and is therefore ideal for premises where life safety is the priority *i.e.* hospitals, nursing homes, hotels, offices, supermarkets, schools and other high life risk occupancies.

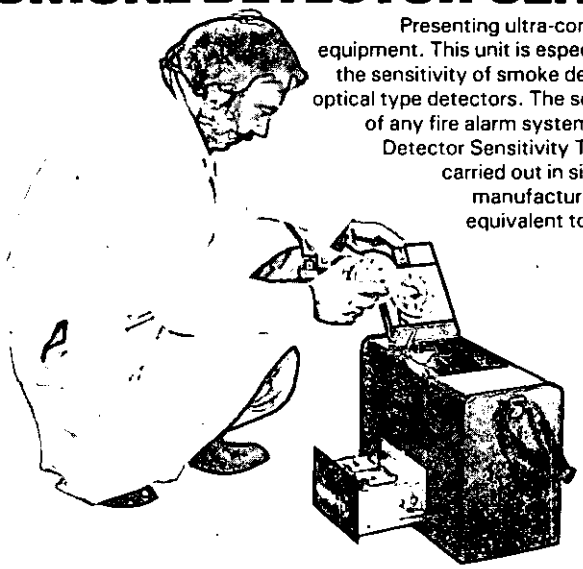
The TSE-A100 Detector Tester can be used for the testing of all kinds of point-type smoke detectors. The smoke, which is generated from a chamber in the handle, can be easily directed into the detector. Even if detectors are situated in an environment having a high air velocity, an adaptor can be fitted to the nozzle to guide the smoke to the detector head. After testing, clean air can be blown into the detector to enable it to be reset immediately, also a built in filter prevents tar or other contaminants from reaching the surface of the detector head which could otherwise possibly cause a deterioration in performance. A detector should operate within 15 seconds if functioning normally, if not, the sensitivity level should be checked with the TSA-B120 Smoke Detector Sensitivity Tester.

THE HAKUTO SMOKE POLE

- ★ Tests *all kinds* of point-type smoke detectors.
- ★ Generates real smoke not a substitute.
- ★ Telescopic construction with controls at the base of the handle for easy testing.
- ★ Complete with a shoulder-slung case with pockets for the accessories for portability.

tisfy themselves that routine tests
s maintain their degree of sensitivity'

SMOKE DETECTOR SENSITIVITY TESTER



Presenting ultra-compact design that outdates conventional testing equipment. This unit is especially designed for fast and accurate checking of the sensitivity of smoke detectors, and can be used for both ionisation and optical type detectors. The sensitivity of detectors is vital in the performance of any fire alarm systems and the introduction of the TSA-B120 Smoke Detector Sensitivity Tester means that the checking operation can be carried out in situ, without having to return the detectors to the manufacturer's factory. Additionally the testing condition is equivalent to the velocity and density of large laboratory and factory testing equipment.

SMOKE DETECTOR SENSITIVITY TESTER

- ★ **Has two densiometer circuits.**
- ★ **The housing is made from duralmin plate.**
- ★ **Lightweight, portable and compact.**
- ★ **Automatic latching of the meter reading and indicator lamp on completion of testing.**

HAKUTO

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The TSE-A100 Smoke Pole together with the TSA-B120 Smoke Detector Sensitivity Tester, will enable those responsible for fire detection systems in any premises to fully meet the requirements specified in the Code of Practice for Fire Alarm Systems BS 5839, which says that it is essential, particularly in the case of detectors installed primarily for life safety, that routine tests are adequate to ensure the detectors maintain their degree of sensitivity. **The Code says that "Users should satisfy themselves on this point." These two new products from Hakuto will enable you to do just that.**
It's better to be safe than sorry.

HAKUTO

EFSEC DIVISION

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