The Journal of the Institute of Hospital Engineering April 1983

HOSPITAL ENGINEERING

The applications of Hyperbaric Medicine

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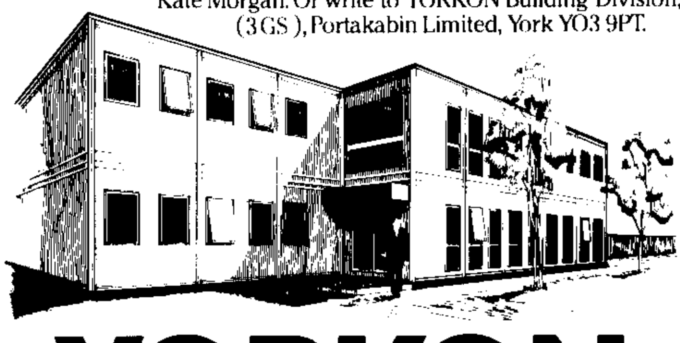

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Front Cover: Our front cover features a copy of a Lithograph depicting Paul Bert carrying out an experiment on the effects of oxygen in 1878. *See R. D. Buckley's article on page 5.*

Institute News

CEI Notice to all Chartered Engineers

Notice is hereby given that an Extraordinary General Meeting of the Council of Engineering Institutions will be held at the Institution of Civil Engineers, 1-7 Great George Street, London SW1 on Thursday 7 July 1983 at 1730 hrs for the purpose of considering the following resolutions:

1. That the Charter and Supplemental Charter of the Council of Engineering Institutions be surrendered and the affairs of the Council be wound up on such terms and conditions as Her Majesty's Privy Council shall prescribe.
2. That the Secretary and such other persons as may be determined by the Board be appointed to carry the foregoing resolution into effect and that the Common Seal be affixed to the Petition for the surrender of the Charter and Supplemental Charter and to any other necessary documents.
3. That, on the completion of the winding up of the Council of Engineering Institutions, the residual assets of the Council shall be transferred to the Institutions which are the Council's Corporation Members in direct proportion to the numbers of Chartered Engineers who are their corporate members of 30 September 1983.

These are Special Resolutions already passed by the Board. Their endorsement by the Membership requires a majority of two-thirds of those present and voting at this meeting which all Chartered Engineers may attend.

By Order of the Board
D. B. WOOD
Secretary

29 March 1983

North Western Branch visit

On Tuesday 22nd February, members of the North Western Branch visited Electricity Board Headquarters in Manchester, where they were given a talk on the new 15th Edition of the I.E.E. Regulations by Mr. W. Edwards, Principal Engineer, Energy Marketing of Norweb.

Mr Edwards gave a broad outline of the new regulations in which he highlighted the difference between the 15th Edition and the old 14th Edition. The talk proved to be most informative and provoked a lively discussion.

The meeting was well attended and the audience included a number of visitors.

Southern Branch Officers

The Honorary Chairman of the Southern Branch for 1983 is Mr S. O. Snow. The Honorary Branch Secretary is Mr R. P. Boyce, 35 Newport Drive, Fishbourne, Chichester, West Sussex, PO19 3QQ. Tel: Chichester (0243) 781411.

East Midlands Branch Secretary

After three years sterling work as Branch Secretary, Mr S. A. Lees has found it necessary to retire.

The entire Branch, and especially the Chairman and Committee, are very grateful to him for his time and effort in supporting the revival of the East Midlands Branch.

The new Honorary Branch Secretary is Mr E. A. Hall and he may be contacted during office hours at Messrs. E. G. Phillips, Son and Partners, 26 Annesley Grove, Nottingham NG1 4GW. Tel: Nottingham (0602) 45783.

Lucas Scholarship Fund

Following the recommendation of the Adjudicators, Council of the Institute has approved a grant from the Lucas Scholarship Fund to enable Mr. M. J. Shand, Engineer of the Southern District, Highland Health Board, to attend the Institute's Annual Conference to be held at the Hotel Piccadilly, Greater Manchester, from 11th-13th May.

Ian Murray Leslie Awards 1983

Now in its ninth year, the 1983 Awards again provide the whole of the building industry with an opportunity to exercise its skills in communication.

For non-members of The Chartered Institute of Building there is the Open Competition with a Premium of £200 and a Silver Medal as top prize. Set subjects for 1983 are: 'Mechanisation — the key to increased productivity?'; 'Gearing the industry to future demand'; 'If builders genuinely believe that they can contribute to the design process, why are they so reluctant to become involved?'

Registration forms and any other details are available from P. A. Harlow, Head of Information, The Chartered Institute of Building, Englemere, Kings Ride, Ascot, Berkshire, SL5 8BJ. Tel: Ascot (0990) 23355.

MacRobert Award 1983

The MacRobert Award of a gold medal and a prize of £25,000 is made annually for 'an outstanding innovation in engineering or the other physical technologies which enhances the prestige and prosperity of the United Kingdom.'

Submissions for the 1983 Award are invited to arrive at the Fellowship of Engineering who act on behalf of the MacRobert Trusts by 1st May.

Further information and details of rules and conditions are available from The MacRobert Award Office, 2, Little Smith Street, London SW1P 3DL. Tel: 01-222 3912.

First lady at CIBS Dinner

The first lady ever to attend a CIBS Annual Dinner in Manchester, Miss Belinda Hatton, a Graduate member of the Institute of Hospital Engineering, is an Engineering Technician with the North Western RHA. The Dinner was held at the Hotel Piccadilly on Friday 4th February and attracted several hundred building services engineers from Authorities, Consultants, Contractors and Suppliers.

Belinda, aged 21, was presented with the Brian Donegani Award, given to the student with the highest mark of all Building Services Courses at Salford College of Technology. The presentation was made by Mr C. J. Parkinson, Managing Director of the How Group.

As a trainee technician of the North Western RHA, Belinda, has passed through the construction industry Training Board Scheme designed to provide a balance of academic study and practical experience.

Having obtained the Higher Technical Certificate, she is now studying for the Final Year of a Building Engineering Services Diploma.

Eighth I.H.F.E. Congress

Melbourne 1984

Now is the time for planning for those intending to participate in the proceedings of the Congress which will be held in Melbourne, Australia, November 18-24, 1984.

The Institute of Hospital Engineers (Aust.) has been conducting annual Conferences for the past 33 years which have had speakers and subjects of a consistently high standard. The Eighth Congress Committee has members with a wealth of experience in conducting these conferences, and they intend that the quality of speakers and subjects will be worthy of an International function.

Apart from the technical proceedings, site visits etc., Melbourne has much to offer a prospective tourist. Delegates to the Congress from interstate and overseas can be assured of a warm and friendly welcome in Melbourne, 1984.

The Committee has made a call for papers, and those wishing to provide material or have their names placed on the mailing list should write to:- The Secretary, 8th Congress Secretariat, I.F.H.E., P.O. Box 302, PRAHRAN, VIC, AUSTRALIA 3181

Forthcoming Branch Meetings

Yorkshire Branch *Hon Sec: J Bate Wakefield (0924) 89011 Ext. 293*

23rd April at 14.00	A.G.M., preceded by 'Fire and Smoke within buildings' — T. Layton Esq., District Fire Officer (Leeds).	Donald Kaberry Lecture Theatre, Leeds General Infirmary

Midlands Branch *Hon Sec: W. Turnbull Birmingham (021) 378 2211 ext 3590*

19th April	Paint Technology Forum	Dental Hospital, Birmingham

North Western Branch *Hon Sec: E. A. Hateley Manchester (061) 236 9456 ext 452*

14th April	Visit to Greater Manchester Police Headquarters to view the communications system	

Southern Branch *Hon Sec: R. P. Boyce Chichester (0243) 781411*

11th May	Visit to Fire Brigade Control Leigh Road, Eastleigh	

Welsh Branch *Hon Sec: T. Roche Cardiff (0222) 755944 ext 2247*

13th April	Annual General Meeting Preceded by Film	Bridgend Ambulance Training School
11th May Day visit	Spirax Sarco Visit to Factory and Apprentice School	

South Western Branch *Hon Sec: A. J. Graver Cheltenham (0242) 21361*

12th April	Annual General Meeting	Committee Room Brentry Hospital, Bath
24th May	History of Building Services and visit to SS Great Britain Mr. N. S. Billington	Charles Hill Dockyard Bristol

East Midlands Branch: *Hon Sec: E. A. Hall Nottingham (0602) 45783*

21st April	Visit to East Midlands Gas Grid Control Centre	Leicester

Those wishing to attend any of the above meetings please contact the relevant Hon. Branch Secretary.

Opinion

Ensuring the best interaction between the interlocking disciplines in the NHS is like completing a jigsaw puzzle, says Dick Bowie.

Until recently there was no picture for Works Officers to go by — now, he says, HN(82)38 Provision of Maintenance Materials *makes a good contribution; but is it good enough . . .*

Wot, No Picture?

The end product of our whole organisation is the health care of the nation. Each discipline working within the Health Service can be likened to a piece of jigsaw, effective in achieving the end product only when matched and interlocked with all other complementary pieces.

Most jigsaw enthusiasts assemble a jigsaw by referring to a picture of the completed scene, consulting the picture to determine the approximate location of the various hues and shapes. Without the picture, the assembly would not be impossible, but would take much longer to complete. As more pieces are assembled, the task would, without the picture, almost certainly involve the transposition or re-orientation of small sub-assemblies to another position on the board in order to finally complete a recognisable picture, pleasing in proportion and colour.

Similarly, the interaction and working practices of and within the various disciplines that make up the health service, require constant review and audit. Without guidance to enable this review to take place, there is a risk that the economical and uniform achievement of the end product may be hindered to the frustration of the staff, as well as to the frustration of those who have need of the service. In spite of the NHS being some thirty five years old (with doses of rejuvenation elixir being administered in 1974 and now in 1983), there are still a great many 'jigsaw' pieces which are being shuffled around in order to improve the quality of the finished 'picture'. (Perhaps this is right, as complacency is not conducive to improvement or progress).

Unfortunately, the Big Bang theory does not apply to the NHS. From Day One in 1948 there was no adoption of a uniform method of doing things. Rather, methods have evolved through personal initiatives at hospital/departmental level, always with one common goal, that of achieving the vision conceived by the architect of a National Health Service.

Today, although that goal remains the same, various Districts, health units within the Districts and even disciplines within the units may go about their tasks in slightly different ways. None of these various methods are necessarily wrong, or bad practice but have evolved or been steered through a course of parochial change in order to suit the exigencies or peculiarities of local needs. How many different systems are employed within the Works Discipline to control the movement of maintenance materials at unit level? Senior Works personnel are mindful of the responsibilities in the control of stores — stock records, security coding, regional/sub-regional suppliers etc., but probably exercise various methods to suit their units particular need — and still satisfy the District Treasurer. However, maintenance materials stores are not an end in themselves, but only a means to an end, and surely the Works personnel should be more concerned with the use of these materials rather than their procurement or issue? Our works stores procedure may work to our satisfaction, and, although we may be aware that there may be some better method, its organisation (or re-organisation) is low on our priorities. What a boon then to know that a 'picture' is available to enlighten us as to how the procurement and issue of maintenance materials should be managed.

HN (82) 38 covers the issue of Report No. CMS A7/81 entitled 'Provision of Maintenance Materials'. This report was commissioned following, to quote 'Dissatisfaction expressed by NHS Works Officers about the existing arrangements in use for the provision of maintenance materials and equipment'.

A 'picture' at last and well timed too as many NHS Works personnel may be having to re-examine the material stores function due to the effects of 'Patients First' on administrative boundaries within Districts.

Alas, though, the full picture (sorry, report) has only been made available to the Regional Administrators, Works Officers and Supplies Officers. In the case of all other recipients of the covering Health Notice, only a summary of the report is available and the reader is, for each summarised recommendation referred to an appropriate paragraph in the full report (which is not available) for qualification. Rather like painting by numbers, but the picture available to Districts doesn't even tell us what colours the numbers represent.

For the reasons stated, many Works Officers may be contemplating a review of maintenance materials stores and embarking on discussions with Supplies Officerss, but what a pity that we haven't been supplied with this 'full colour picture' to aid us in our deliberations in matching and bringing together the jigsaw pieces of our own discipline with those of the Supplies Department.

Dick Bowie

The author is currently Manager of Works Maintenance for British Caledonian Airways. Until December 1981 he was District Works Officer at Warrington Health District.

The Application of Hyperbaric Engineering

R D BUCKLEY, DMS MPhil FIHospE FBIM FIIM

Introduction

This paper has been written to give health care engineers an up to-date and wider insight into the development, operation and installation of the equipment used in this specialist branch of medical treatment. It should be stated at the outset that hyperbaric medicine is not a new concept, however, it is at an interesting stage of development.

From an engineers viewpoint there can be seen many interesting applications of the use of equipment, which range through the use of hyperbaric systems to aid deep sea diving operations in such fields as oil exploration, to those applications which aid directly as a treatment aid in hospitals for patients suffering from severe burn or limb disorders.

Man may be described as an 'aerobic' (i.e. an organism dependent upon air as a metabolite) who uses air in a narrow zone of pressure, commonly referred to as atmosphere, which is equal to about 1013m bar. Above or below this zone he begins to suffer toxic effects until at extremes he becomes unconscious and dies if allowed to remain in the extreme environment. In very basic terms hyperbaric medicine is concered with modifying this critical pressure zone and saturating the body with oxygen at elevated pressures. It should be noted that this process does carry certain risks, and it should be realised that oxygen in its pure form is considered to be a drug which if administered in an overdose will reflect a toxic change. Likewise other inert gases present in the atmosphere become reactive and toxic if given under pressure. In modern hyperbaric medicine there are still differences of medical opinion regarding the dose and pressure that oxygen should be administered for the treatment of various diseases.

This paper does not set out to be exhaustive in its depth, but it is intended to cover those applications that may be found in common use today in the hospital situation.

Development of the Hyperbaric System

Hyperbaric medicine with its 'Jules-Verne' type of equipment has at times been the subject of sensational reports in the lay press and of confused claims and counter claims in the medical literature. Unfortunately in the United Kingdom the history of hyperbaric medicine has largely been undistinguished and misunderstood except for a few notable exceptions. It will come probably as no surprise to learn that its application in the treatment of disease was first recognised by a British physician named Henshaw in1662[1].

In considering the development of hyperbaric medicine the following three main phases can be identified:

1. 1662 – 1885
2. 1920 – 1940
3. 1955 – to date

It will be seen that these three periods do not follow consecutively. This is because interest in this branch of medicine has followed certain fashions some of which have fallen into disrepute as other branches of medicine have advanced.

The first period

1662 – 1664 The British physician Henshaw first sought to use the principle of hyperbaric medicine for the treatment of patients. He developed the first specially equipped room which he called a 'domicillam'. This room was in use in 1664 and was used for the treatment of various ailments. Henshaw believed that with his equipment a person might receive the benefit of removal to another climate at any time of the year while remaining in his own locality without neglecting his employment. The results of this work are unknown[1].

1830 In this year three French physicians 'Junod of Paris', Tabarie of Montpellier' and 'Pravaz of Lyons'[2] started a flurry of activity for the medical use of hyperbaric oxygen. Indeed Junod of Paris is credited with the design of the first therapy chamber, a copper sphere some 1.5m diameter. Such developments continued. Tabarie claimed to have treated successfully 49 patients with respiratory disease and was the first person to attach importance to the need to raise and lower the pressure of the chamber slowly. Pravaz built the largest chamber of the day capable of holding 12 patients

It is worth noting along the way that Triger a celebrated French engineer in 1841 developed a Caisson for excavating the bed of the Loire River (depth 20 metres). He was the first to record Caisson disease, which is caused by rapid decompression to atmospheric pressure.

1850 From this date onwards it was seen that the medical profession had developed a proliferation of medical pneumatic centres throughout Western Europe. For example Fornanini[2] in Milan, director of the 'Pneumatic Institute', was a pioneer in the application of hyperbaric treatment for tuberculosis. His theory was that acute consumption was best treated at low pressure.

1878 It was reported that Dr Fontaine had performed 27 operations in a mobile hyperbaric chamber. He felt that patients recovered from the effects of nitrous

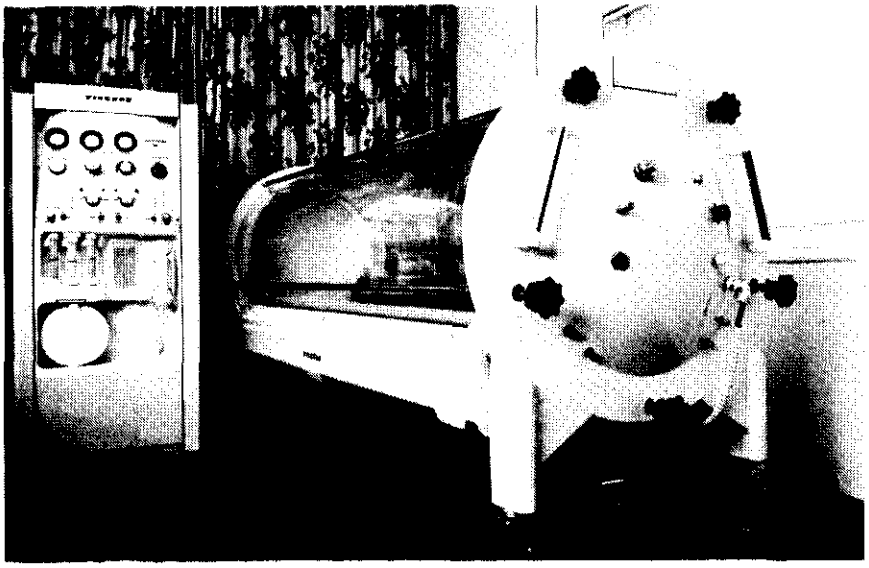


Figure 1: A typical Hyperbaric Chamber.

oxide anaesthetic more rapidly and that the incidence of cyanosis and asphyxia was reduced. He planned a 300 seat hyperbaric ampitheatre but was killed accidentally by a falling beam in his Institute before the project was started.

This year also saw perhaps the first scientific approach to the development of hyperbarics. Paul Bert, a French physiologist, gathered the scattered knowledge in the field and together with his own research published the large volume 'La Pression Barometrique.[3] His most important findings was the txoic effect of increased oxygen therapy on the central nervous system. The popularity of hyperbaric therapy in the 19th Century faded at the entrance into the 20th Century and experimentation for all practical purposes was abandoned.

The Second phase

1920 The second phase may be identified as commencing in the United States of America and is an example of European technology being exported, for a change. In this year a Dr Orval J. Cunningham of Kansas constructed a high pressure therapy unit during a flu epidemic. This chamber was 13m in diameter and 27m long, containing private compartments and toilets. He claimed to cure such diverse diseases as diabetics, syphilis and cancer. His rationale for the treatment was that these diseases were caused by anaerobic bacteria. He postulated that these bacteria could be killed by increased oxygen tensions caused by increased pressure.

1927 Another doctor called Cunningham persuaded an industrialist called Timken that he had developed a miracle cure, thus was formed in December 1928 the 'Timken and Cunningham Hyperbaric Institute'. The Institute was equipped with horizontal cylinders equipped like pullman cars (up to 12 people) including toilets, showers etc. The centre-piece of the Institute however was a steel sphere 20m in diameter, at its centre was a staircase and elevator shaft. The first floor a dining-room; the second and third floors contained 36 bedrooms for patients and the fourth floor was for recreation. The units could be pressureised to 2 bar. In 1935 Cunningham died and the Institute was closed.

1935 - 1950 During this period only one notable paper was produced by Behnke, a Captain in the United States Navy. He suggested the possibilities of treatment on the first scientifically based principles. His work, however, was largely ignored.

The third phase

1956 The impetus for our present phase of hyperbaric development was stimulated by Dr Boerema.[4] In an article published in this year he showed that pigs could survive with virtually no red blood cells if oxygen was physically dissolved in a circulating plazma.

Contempories of Boerma stimulated by his work developed other ideas notably Churchill-Davidson of London studying the effects of hyperbaroxia in combination with radiation therapy on solid tumours and Illingworth and Smith of Glasgow on clostridial infections.

At about the same time, Ledingham and others in Scotland and England began the use of hyperbaric oxygen (HBO) in the treatment of carbon monoxide poisoning. Their results were reported at the First and the Second International Conferences on Hyperbaric medicine in Amsterdam (1963) and Glasgow (1964). Good results were shown in the treatment of clostridial myonecrosis (gas gangrene) and carbon monoxide poisoning. These investigators also introduced the concept of open heart surgery in large (operating-room size) hyperbaric chambers; and several of these large centres were subsequently installed in United States civilian medical centres. Since results in the use of these chambers for vascular surgery were generally disappointing, this concept is seldon employed today and many of the large expensive chambers are no longer in use. Cheaper, monoplace chambers were introduced in the 1960's to allow radiation therapy of cancer in hyperbaric oxygen. By the late 1960's, views regarding HBO were divergent - some investigators saying it was entirely useless, and others claiming miraculous cures.

1980's Today many centres are developing methods of treatment from these basic concepts. In a sense current developments have been stimulated by man's desire to explore the depths

Figure 2: The door to the Chamber.

both in the oceans and outer space. Accordingly much of present day research is being carried out in the military field.

At the present time there is a renewed general interest in the United Kingdom. The benefits of hyperbaric medicine are now more widely recognised as an adjunct in the treatment of many critical disorders. In this respect provision is now being made on new chambers for the full range of essential equipment to be used on patients while undergoing treatment. This aspect being particularly relevant in the intensive care situation, where provision of PO_2 and PCO_2 monitoring is very important. A typical chamber is shown in *Figure One*, the special connections to the chamber in *Figure Two*. It will be seen that today's chambers are usually sized for single occupation, multiple occupation chambers are in use however, but these are costly and have the disadvantage of being immobile.

The Hyperbaric System and the Gas Laws

In order to understand how the hyperbaric system operates it is necessary at this point to look at the scientific principles upon which the system relies. It should be understood that compression chamber treatment of any disorder or disease is based on only three physical factors all related to the hyperbaric environment.

The first concerns the mechanical compression of gas filled entities (such as bubbles) which respond according to 'Boyle's Law'. This law states that if the temperature is kept constant, the volume of a gas will vary inversely to the absolute pressure, while the density varies directly to the pressure. This can be expressed mathematically as:

Hence p is proportional to $\frac{1}{V}$

that is, p $\frac{1}{V}$

therefore $p = \text{constant} \times \frac{1}{V} = \frac{C}{V}$

hence $pV = C$, at constant temperature;

that is: Pressure × Volume = Constant

Secondly, the elevation of the partial pressures of inspired gases in accordance with 'Dalton's Law'. This law states that the pressure of a mixture of gases are respectively equal to the sums of the pressures of the individual constituents when each occupies a volume equal to that of the mixture at the temperature of the mixture. This can be expressed mathematically as:

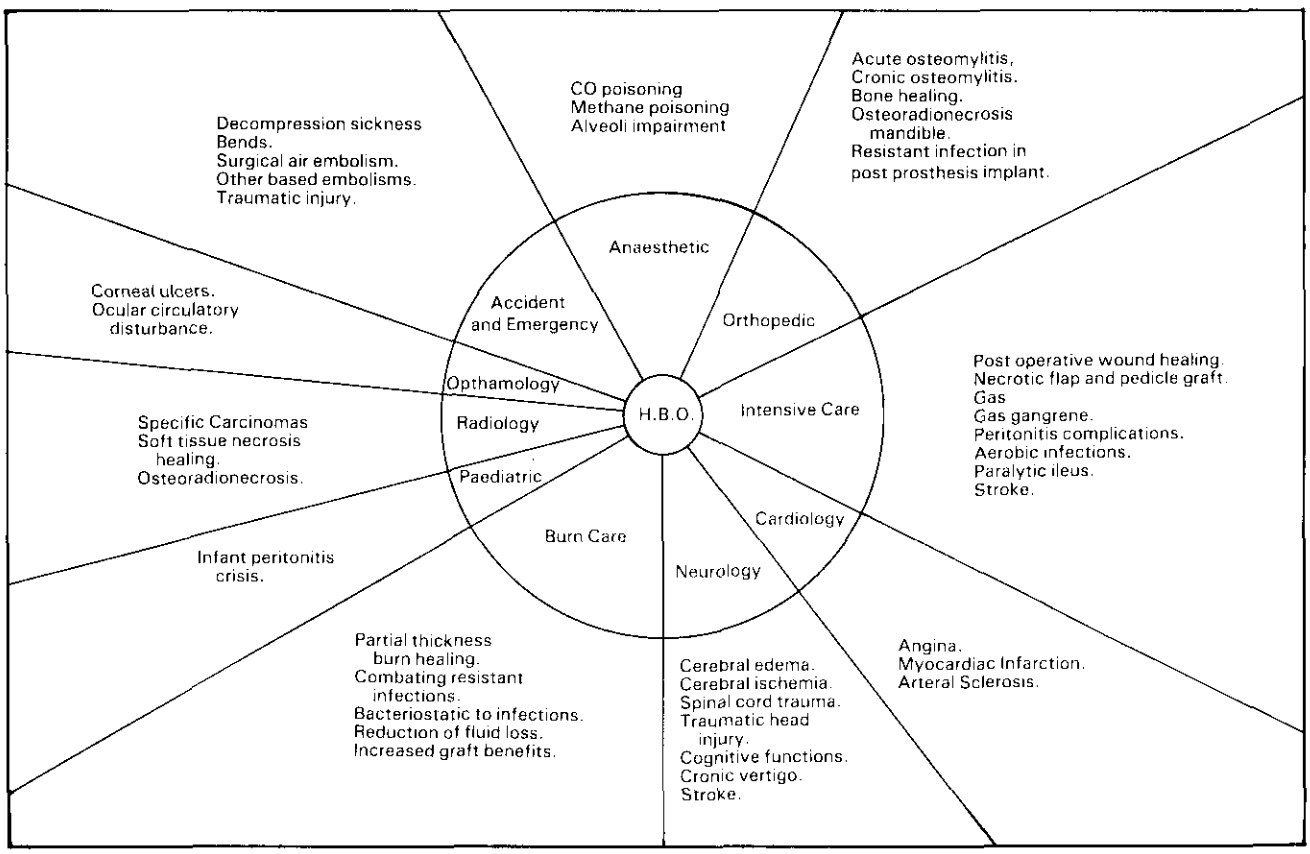
P = Pi V,T where Pi = partial pressure of each individual gas.

Finally the dilution of gas dissolved in a liquid at a given temperature is given by 'Henry's Law'. This states that the amount of gas dissolved is nearly proportional to the partial pressure of the constituent gases.

In practical terms it will be seen that the application of these Gas Laws means that not only can the volume of a particular dissolved gas be controlled (particularly important in the decompression of divers) but that the partial pressure of differing constituent gases can be used to advantage (for example, in the removal of carbon monoxide after poisoning).

The vast range of treatments that are available today which are an extension of the basic principle outlined, can be seen in *Table 1*. In the treatment of severe burns the benefits of saturating the blood stream with oxygen become very apparent when

Table 1: Hyperbaric Oxygen Therapy in the Modern Hospital.



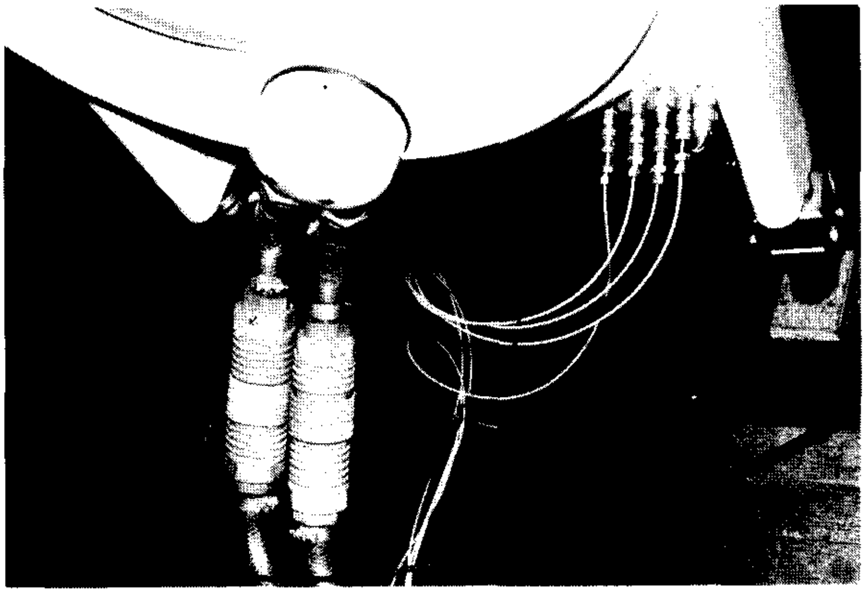


Figure 3: Extract hose connections with quick-release device.

the overall length of recovery is considered.

Installation Requirements

There are no major problems associated with the installation of hyperbaric units. Attention must, however, be paid to the possible fire hazard due to the use of oxygen. This hazard is usually overcome by ensuring that the normal safety precautions are applied and, of particular importance are the antistatic aspects regarding patient and staff clothing.

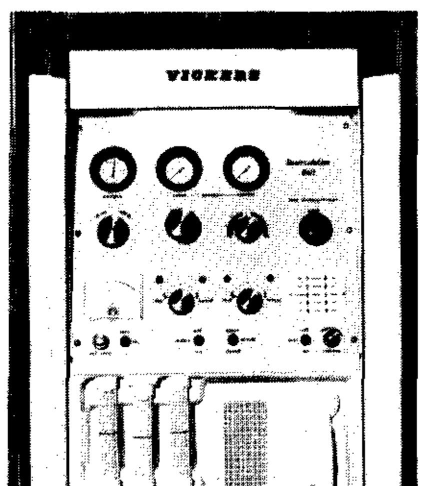
Installations are not normally fitted with antistatic flooring, however a floor covering with antistatic properties is necessary.

It is usual to provide a separate piped supply of medical oxygen to the unit with its own separate stop valve and low pressure alarm. A quick release valve connection is also required. The room where the hyperbaric unit is situated should be fitted with a mechanical extract to ensure that any oxygen leakage is removed from the room quickly.

The unit is fitted with an extract hose connection normally that vents to atmosphere. This should be fitted with a quick release mechanism to ensure that if the patient should have to be moved in the chamber to a different location that this can be achieved quickly. *(see Figure Three).*

The main control panel shown in *Figure Four*, requires a normal single-phase electrical supply which is connected to the essential electrical services distribution.

Figure 4: Main control panel.



Conclusion

Today, as has been seen, hyperbaric medicine is far removed from the bizarre applications which were seen to be developed by medical practitioners in the early days. There is no doubt that the theoretical basis for this type of treatment is now better understood and gaining ground as an adjunct to the treatment of many acute disorders. When used as a main method of treatment on its own its use is critical for many medical disorders that cannot be remedied by other methods of treatment.

As has been seen hyperbaric medicine is still developing. Although there is nothing revolutionary in the concept it does appear to have considerable potential for the future. It is noted that the technology involved is not expensive and the running costs are minimal.

It is hoped that the foregoing has provided a brief insight into the engineering aspects of this special piece of medical equipment. With the renewed interest at the present time by medical practitioners in this treatment, it is likely that more special units will be introduced into United Kingdom hospitals. It appears from the research undertaken for this paper that the most likely areas for installation will be adjacent to intensive care units as a special treatment facility. Although it has not been possible to cover in depth all the aspects in this field should engineers wish to pursue any or obtain any reference the author would be pleased to hear from them.

Acknowledgements

The author wished to acknowledge the help received in providing information for this paper from Vickers Medical Limited and the Staff at the Heatherwood Hospital, Ascot.

The author also wishes to acknowledge the information used on the historical aspects which were taken from the paper presented by Captain George B. Hart, MC, USN, at the proceedings of the San Diego Biomedical Symposium in 1973.

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Until his retirement in February last year Mr Eatwell was Regional Engineer at the South West Thames Regional Health Authority. A senior Council Member for many years he is currently Chairman of the Finance and General Purposes Committee.

An Incinerator Flue that failed twice

K J EATWELL OBE CEng FIMechE FCIBS CIHospE

Background

In 1977 the South West Thames Regional Health Authority decided to upgrade the steam boiler plant at Botley's Park Hospital, Chertsey, Surrey to meet an increasing demand from new development on the site. The works included the replacement of manual oil burning equipment with automatic dual fuel burners using natural gas as primary fuel, 3500 second fuel oil as secondary fuel and the provision of separate steel liners for each boiler and the incinerator — using an existing brick stack as windshield.

The incinerator installation comprises a single, natural gas fired, unit in a purpose-built brick housing circa 1968, of Hodgkinson Bennis manufacture complete with hearth, afterburner and waterbath. A short length of horizontal steel refractory-lined flue connects the incinerator to the new steel refractory lined liner. Firms tendering were required to design, supply and install complete, the chimney and flue system for boilers and incinerators. The new incinerator flue was brought into use in December 1979.

The First Failure

Routine cleaning on 17th April, 1980, revealed a substantial proportion of refractory lining material mixed with the ash at the bottom of the incinerator flue. Further detailed inspection revealed areas of steel liner devoid of all refractory lining. In addition, the bottom of the steel liner was buckled.

The Regional Health Authority, in conjunction with the Contractor decided to check design, construction and operation and the following are the details.

The flue liner of 600mm bore, was constructed from 6mm thick mild steel plate to BS4360, externally flanged, in sections, each section approximately 6m long. Total height of the flue above ground about 40 metres. It was lined internally with 50mm thick 'Densecrete' High Aluminium Cement refractory manufactured by Cement Gun Co. Ltd., and thermally insulated externally with 50mm mineral wool. The maximum working temperature of the refractory lining was stated as 1100°C.

A steelwork structure within the brick windshield was provided to accommodate the total weight of the liners. This structure formed part of one of the five access platforms inside the windshield.

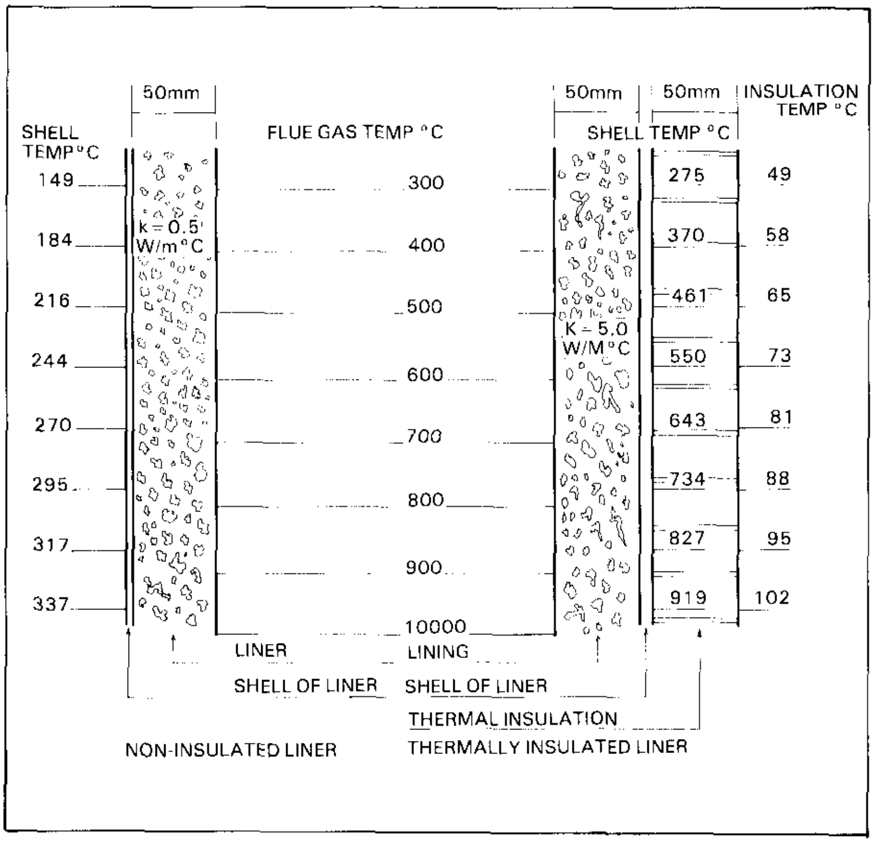
The refractory lining had been applied and cured on site.

Three theories of failure

Initially it was thought that failure had occurred as a result of excessively high temperatures brought about by overfiring. Tests carried out by the British Ceramic Research Association indicated that the failed refractory material had not experienced temperatures beyond 800°C i.e. well within the manufacturers' 1100°C maximum operating temperature. Subsequent measurements indicated a maximum operating temperature of about 670°C.

A second theory advanced was that failure of the refractory lining was due to the manufacturers' recommended commissioning procedure not being followed. This procedure is to raise the temperature of the refractory from ambient to maximum operating temperature at a rate not exceeding 25°C per hour with a minimum of 6 hours hold at 100-150°C. Commissioning was carried out by use of the incinerator.

Yet another explanation proposed that failure was caused by the thermal insulation on the outside of the steel liner preventing heat dissipation from the outer surface of the steel, particularly as the brick windshield was virtually unventilated. It was estimated that at a flue gas temperature of 670°C the steel liner temperature would be 616°C with 50mm mineral wool thermal insulation around the liner. At this temperature it was considered that the liner was overheated and the lower sections buckled under their own weight,



causing the refractory to break away. Fig. 1 (provided by Cement Gun Co. Ltd.) shows variations in temperature across thermally insulated and non-insulated refractory lined steel liners for various gas temperatures and 50mm Densecrete.

It was concluded that failure probably occurred as a result of the second theory, i.e. *curing procedure* not followed.

The Contractor accepted full responsibility for failure and agreed to replace the damaged sections of the steel liner and provide a new refractory lining at his expense, using the following operational data as a basis for design.

Temperatures
Maximum measured gas temperature - 670°C
Average measured gas temperatures -450°C
New design temperature -800°C
Periods of Operation
0800 - 1700 Monday to Friday
0800 - 1200 Saturday
Waste to be Incinerated
90% paper (high proportion wet or saturated).
10% plastics.
Refractory Lining
50mm thickness of 'Densecrete' (as *originally*) anchored by stainless steel 'V' studs of 25mm projection at 300mm centres circumferentially and 600mm centres longitudinally.

Steel Liner Temperature
This would be approximately 295°C mean. No thermal insulation to be applied. Insulation had been provided initially for personnel protection as *the design included internal access* within the windshield for inspection and maintenance purposes. In view of the problems arising out of insulating the liner it was agreed to omit the insulation and carry out maintenance and inspection during periods when the incinerator was not in use.

The damaged sections were replaced, the whole of the refractory lining renewed and the incinerator flue put back into service in July 1980. The Health Authority expressed doubts as to the suitability of using the same refractory lining product but following assurances from the manufacturer the Contractor went ahead as planned.

The Second Failure

Following remedial works to the incinerator flue it was decided to carry out inspections at regular intervals in order to monitor performance.

Inspection — 6th September, 1980

The first inspection was made on 6th September, 1980. No deterioration was apparent and a further inspection was arranged for 1st November, 1980, about 13 weeks after re-commissioning, as this period would coincide with the original period between commissioning and discovery of the first failure. The exact time of the first failure was not known.

Inspection — 1st November, 1980

Some evidence of 'Flaking off' of the refractory was apparent. This was explained by the manufacturer as being a result of 'on-site' application of the refractory material in the wet state. Tamping down *the material* would tend to bring some of the cement to the surface of the lining. The partially sealed area thus formed would tend to spall the cement layer off on first firing of the incinerator due to steam pressure within the lining. It was anticipated by the manufacturer that further spalling would not take place once the cement layer had been removed.

Inspection — 10th January, 1981

Significant signs of deterioration were seen. Approximately 140 litres of a mixture of ash and refractory lining material was removed from the *base of the incinerator flue. It* was estimated that at least 50% of the debris was refractory material. It could be seen that flaking off was occurring from the surface of all the refractory lining visible through the bottom cleaning door, although the surface was not affected uniformly, some local areas were more badly affected than others. It was decided to increase the frequency of inspections in view of the earlier failure.

Inspection 24th January, 1981

Disintegration of the refractory lining was continuing at a uniform rate. At this point it was suggested by the manufacturer of the refractory that a possible cause of deterioration was the operating temperature of the incinerator flue dropping below 150°C. This would result in condensation of certain acidic gases which would then attack the refratory. It was agreed that a specialist firm should be approached to carry out an analysis of the incinesrator flue gases with a brief to particularly search for gases which could contribute towards deterioration of the refractory. At the same time the flue gas temperature would be monitored at incinerator level and at the top of the stack throughout the duration of the tests. The tests to be carried out over a two day period with the waste to be as representative as possible of the normal incinerator load. During the period necessary to organise the analysis further inspection were made. The results, including earlier inspections are shown tabulated.

Date of Inspection	Remark
6.9.80	No deterioration.
1.11.80	First signs of flaking-off.
10.1.81	Significant deterioration approx. 140 litres of refractory material removed.
24.1.81	Deterioration continuing approx. 28 litres of refractory material removed.
10.2.81	Deterioration continuing. Approx. 28 litres of refractory material removed.
2.3.81	Deterioration continuing. Approx. 28 litres of refractory material removed.
3.4.81	Deterioration continuing. Approx. 28 litres of refractory material removed.
13.5.81	Deterioration continuing. Approx. 40 litres of refractory material removed. Thicker particles than previously.
3.6.81	Deterioration continuing. Approx. 70 litres of material removed.

Results of Flue Gas Analysis

The Analysis was carried out by Yarsley Technical Centre Ltd., Redhill, Surrey, on 15th and 16th July, 1981. A mobile laboratory was used.

Summary of Results

During the analysis the presence of eight gases other than water vapour were sought and on no occasion did their total concentrations exceed 0.05% by volume, a concentration which should have no significant effect on properly glazed flue linings. Recordings of temperatures at the top of the stack and at incinerator level were taken over the two day analysis period. This showed a large temperature differential between top and bottom of the flue with a wide range of fluctuations in temperature at incinerator level.

Table 1. Flue Gas Analysis and Temperature Recordings 15th July, 1981

Time	Gastec ppm			Wet Chemical ppm						Temp. °C		Remarks
	H_2S	CO	H_2O	HCl	SO_2	NO_X	HF	NH_3	HCN	Bottom	Top	
10.15–10.45	30	200	13889	4.4	13.6	1.8	1.9	ND	ND	700 750 650	270 460 460	Rubber being burned
11.15–11.45	5.0	40	13889	2.2	13.6	0.3	0.98	ND	ND	600 900 700	400 440 425	General rubbish being burned
12.00–12.30	1	20	16667	1.4	24.9	0.6	2.3	ND	ND	660 450 380	420 390 330	
13.03–13.33	ND	10	27778	25.4	25.3	0.7	3.4	ND	ND	500 520 400	360 360 320	Operator at lunch, incinerator close up for duration of test
14.45–15.15	ND	150	25000	4.5	4.0	1.4	1.4	ND	ND	680 480 720	350 260 390	Black polythene bags being burned
15.30–16.00	ND	50	25000	18.8	68.3	1.1	2.0	ND	ND	700 740 820	420 420 450	

Notes:
ND — None detected
* — Recorded at 15 minute intervals.

Method

The gases actually sought were:-

Gas	Formula
Chlorine and Hydrogen Chloride (as HC1)	HC1
Sulphur oxides as sulphur dioxide	SO_2
Oxides of Nitrogen	NO_x
Hydrogen Fluoride	HF
Ammonia	NH_3
Hydrogen cyanide	HCN
Hydrogen sulphide	H_2S
Carbon monoxide	CO
Water Vapour	H_2O

Gas examples were taken from the point where the flue gases left the incinerator and entered the flue. Two methods of gas analysis were used:

1. 'Gastec' specific absorption tubes.
2. Absorption in a wet chemical train.

1. The 'Gastec' tubes were used basically as a qualitative detector to verify the presence of specific gases in the flue gas stream and for measuring the concentration of H_2S, CO and water vapour.

2. The wet chemical analysis was carried out by drawing a sample of the flue gases at a known rate through an absorption train containing alkaline peroxide solution for a pre-determined period of time. The absorbent solution extracted all acid gases (HC1, SO_2, HCN, HF and NO_x) also ammonia (NH_3). The quantities absorbed were determined by standard methods of chemical analysis in the laboratory.

Measurement of Flue Gas Temperature

A multi-point Cambridge recorder (range 0-1000°C) together with chrome/alumel thermocouples were used to measure the flue gas temperatures. At the bottom of the the flue a thermocouple was inserted adjacent to the point at which gas samples were taken. Compensating leads connected the thermocouple to the recorder. At the top of the flue a thermocouple was suspended inside the flue on the centre line, approximately 600mm from the top. Compensating leads from this thermocouple were connected to a compensating box fixed to an internal access platform near the top of the chimney. The compensating box was connected via twin core cable to the recorder at ground level. The temperature conditions were monitored for the whole of the analysis period, including overnight on the 15th July to obtain information on cooling down.

The results of the flue gas analysis and the temperature recordings are given in Tables 1 and 2.

Observations

Gas Composition

It has been shown that acidic gases were present in the flue gas during operation of the incinerator. If condensation of these gases occurred

Table 2. Flue Gas Analysis and Temperature Recordings 16th July, 1981

Time	Gastec ppm			Wet Chemical ppm						Temp. °C		Remarks
	H_2S	CO	H_2O	HC1	SO_2	NO_x	HF	NH_3	HCN	Bottom	Top	
10.00 – 10.30	5.0	60	6944	4.2	28.1	1.1	1.4	ND	ND	380 520 480	240 300 320	Mainly paper being burned and some "Burn Bins"
10.35 – 11.05	ND	200	9722	19.7	20.1	0.7	1.7	ND	ND	700 520 620	340 380 360	Black polythene bags and card-board boxes being burned
11.31 – 12.01	ND	200	13889	11.6	4.0	1.0	1.8	ND	ND	480 570 600	360 380 400	Pathological waste in polythene bags being burned
12.04 – 12.34	ND	10	19444	31.2	4.0	0.3	1.5	ND	ND	660 610 720	410 430 440	High plastics content in rubbish
12.40 – 13.40	NS	NS	NS	19.5	ND	0.1	2.6	ND	ND	500 520 500 500 400 340	400 400 380 380 340 320	Operator at lunch, incinerator closed up for duration of test
14.00 – 14.30	ND	10	19444	10.5	4.0	0.1	2.0	ND	ND	680 720 480	410 430 400	
14.35 – 15.05	10	30	19444	33.3	6.0	0.2	2.1	ND	ND	580 380 360	410 360 340	Black polythene bags being burned

Notes:
ND — None detected
NS — Not sought
* — Recorder at 15 minute intervals

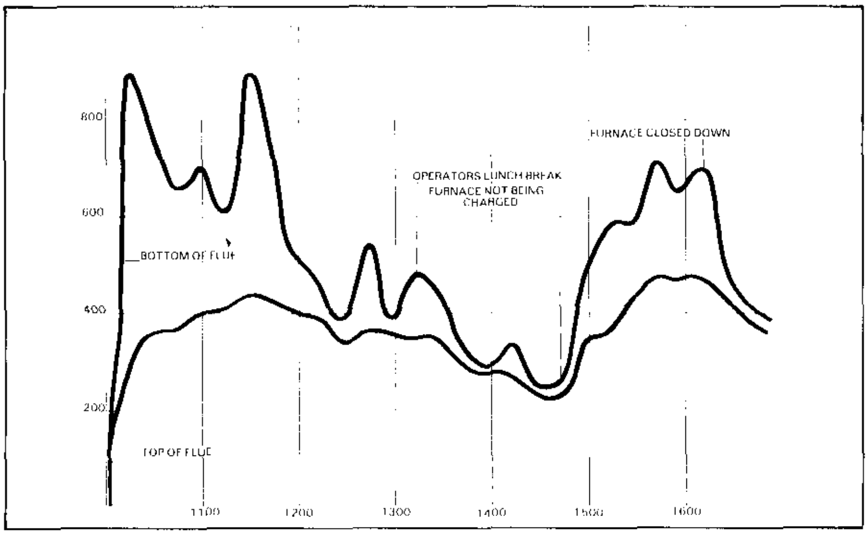


Figure 2: Flue Gas Temperatures Obtained 15.07.1981.

within the flue, the residual acids could with time attack the 'Densecrete' lining. However, the total concentration of acidic gases found was relatively small compared with the total volume flow of flue gas. The type of waste material being burned did not appear to significantly affect the overall composition of the flue gas, although the H_2S content increased when rubber was being burned and HC1 level rose when plastics were burned.

Flue Gas Temperature

There was a very rapid heat up period at the beginning of the test period on 15th July. It can be seen from Fig. 2 that the temperature rose at the bottom of the flue from about 40°C to 900°C in 15 minutes. During subsequent operation of the incinerator the temperature at the bottom of the flue fluctuated widely as did the temperature differential between the top and bottom of the flue. It is also evident that on cooling a point was reached where the temperature at the top of the flue exceeded that at the bottom.

Conclusion

The results of the flue gas analysis does show that the operating conditions within the incinerator flue are more or less what one would expect to find with a typical hospital incinerator in so far as temperature and gas composition are concerned. It may be that the principal cause of failure of this particular lining was the temperature fluctuation rather than chemical attack. However, as mentioned at the beginning of this paper design of the flue, including selection of the refractory lining material was the responsibility of the firms that tendered for the work.

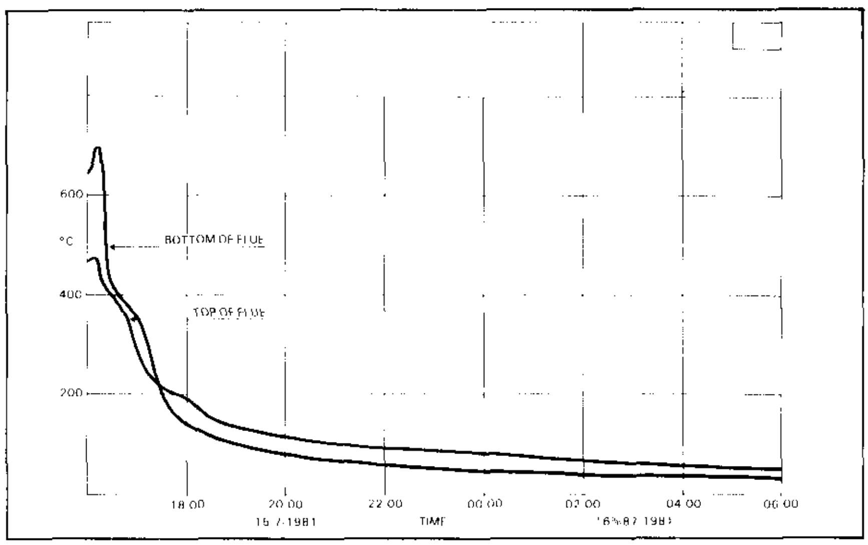
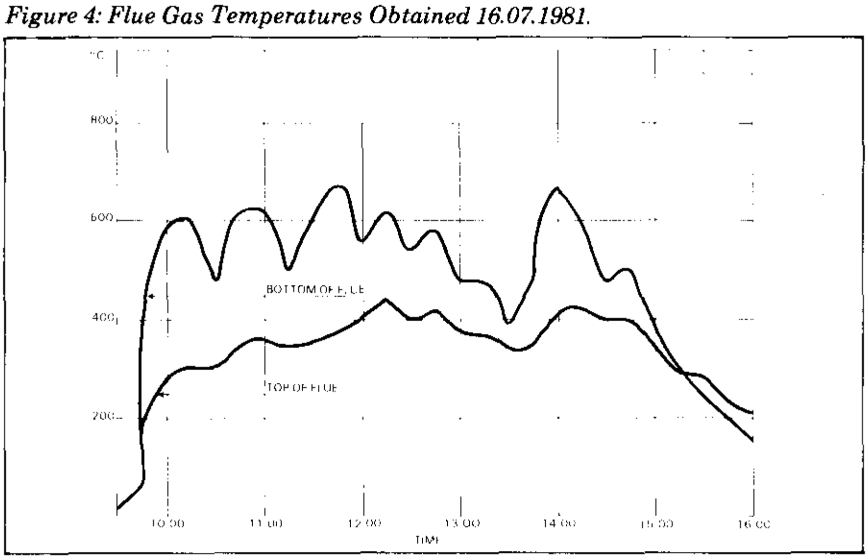


Figure 3: Flue Gas Temperatures Obtained 15/16.07.1981.

Figure 4: Flue Gas Temperatures Obtained 16.07.1981.



At the time of writing a satisfactory solution to the problem is yet to be found and discussions are currently being held with the Contractor. That deterioration is continuing is evident from the most recent inspection made on 9th September, 1981, when some 200 litres of granulated refractory material was removed. Further, refractory material has recenlty been observed to issue from the top of the flue and at least one car owner has reported damage due to falling material.

It is the intention of the author to describe the final steps taken in achieving an acceptable incinerator flue in a future article. In the meantime, those who may be considering the installation of a refractory lined incinerator flue in a similar situation should pay careful attention to the selection of refractory material.

Mr Furzey is Manager HVAC Department, Southern Region, Flakt Products, Staines.

Bonus for hospitals from heat recovery

C G FURZEY MCIBS

Introduction

Around-the-clock operation of the air conditioning equipment in hospitals required to maintain essential environmentally-controlled conditions can have considerably potential for major savings in energy costs. It is estimated that 70-80 per cent of the energy supplied to hospitals is utilized for heating the ventilation air. When the energy bill of one major London Hospital is more than £1 million a year at current rates, the picture on a national scale and potential savings start to come into proper perspective.

No less important is the need to reduce consumption and conserve finite fuel resources. As a result, justifying installation of heat recovery equipment is a simple task with the increasing costs of energy. Pay-back periods and savings can exceed forecasts due to increasing energy cost inflation.

An additional attraction is that supplementing the air conditioning installation with heat exchangers fitted in the supply and exhaust air systems with a piped fluid interconnection can be a relatively simple task, and can result in a considerable saving in energy.

Liquid coupled systems

Use of a liquid coupled system has a number of advantages from the clinical aspect, not least overcoming the possibility of any cross-contamination between supply and exhaust air streams. During the summer months the system can simply be switched off or can be utilised to recover cooling energy if the supply air is mechanically cooled.

Although there are no specific case histories in the United Kingdom it is possible to give European examples which have already set a lead with tried and proven installations since the mid 1970's. At the outset, however, acceptance of the concept is essential.

Hospitals with mechanical supply and exhaust air ventilation represent a relatively homogenous group of buildings offering particularly good potential for saving energy by installation of heat recovery equipment in the air conditioning systems.

As one example, faced with increased energy prices, the Eastern Clinics in Jönköping, Sweden, decided to install heat recovering equipment in 1975. The central air treatment equipment comprised an air supply unit and two exhaust air fans. The distance between the supply and exhaust fans is about 15m (50ft) and a Flakt Ecoterm liquid-coupled system was selected.

The central supply air unit at the clinics supplies an air quantity of 24m^3/s (51,000cfm) and is in operation around-the-clock. Existing humidifiers were removed from the unit — a common energy-saving measure adopted in many hospitals. Removal of the humidifier also compensated for the additional pressure drop caused by the heat exchanger and an extra supply air filter. It was therefore unnecessary to increase the speed of the supply air fan.

As in many installations, no space was available for the heat exchanger down-stream of the existing supply air filter — in this case a roll filter. As a result it was necessary to fit the heat exchanger with a simple, panel filter which was secured directly to the face of the exchanger.

Because of space restrictions it was not possible to provide the two 12m^3/s (25,500cfm) exhaust air fans with heat exchangers and exhaust air filters were installed in a separate plant room located on the roof above the two fans. To maintain the design air flow, the belt, pulleys and fan motors were replaced in order to achieve the higher fan speed required.

Subsequent tests showed that the heat recovery system was efficient to 50 per cent and annual gross energy savings were in the region of 2,600 MWh, including an allowance of 50MWh for losses in pumps and fans.

Maintenance comprises primarily of changing the filters. This is carried out by hospital personnel during routine maintenance of the air conditioning plant.

In another installation at Kristianstad where the hospital was commissioned in 1973, the original air conditioning plant was supplemented with four separate Flakt Ecoterm heat recovery systems between 1975 and 1977. Total supply air volume is

115m³/s (224,000cfm) and corresponding exhaust air volume 94m³/s (200,000cfm). The required supply air temperature downstream of the heat exchangers is 12 Deg C (54 Deg F). In some of the systems the air volume is reduced during the night.

The exhaust air heat exchangers were also fitted with the same panel filters as at Jönköping. This also applied to the heat exchangers on the supply air side which could not be accommodated downstream of existing supply air filters. It was necessary to change belt pulleys and fan motors in some of the systems to allow for the increased pressure drop across the heat exchangers and filters.

In any event, temperature efficiencies of the heat recovery systems have been calculated at between 45 and 50 per cent. These moderate figures were due to the relatively low exhaust air volume in relation to the supply air volume. In spite of these figures the actual saving in oil consumption exceeded the forecast of 794,850 litres (174,843 gallons) per annum.

Hospital maintenance staff are responsible for changing the filters which are equipped with pressure switches and therefore changed when required rather than at regular intervals. Over the period it has been found the supply and exhaust filters are changed twice a year.

The viability of the use of heat recovery equipment can be proved and estimates of savings in energy costs are often exceeded. The ability and versatility of such equipment to be installed after original ventilation systems have been in service is another major factor in spite of associated complications of positioning or lack of space.

To create systems which are reliable and require little maintenance, the most important aspects are correct design of pipework and to ensure adequate provision of facilities for simple and reliable venting.

In new buildings installation of a heat recovery system can not only reduce annual energy consumption but can allow a reduction in the capacity of the primary heating plant installed in the building. In a building employing cooling during the summer, the capacity of the primary cooling system can also be reduced.

Cost and cost calculation

In this connection the reduced cost of the primary heating and cooling plant can well exceed the cost of the heat recovery system. In such cases, the heat recovery system will already have paid for itself when it is installed.

In any event, while it may be time consuming to calculate capital costs

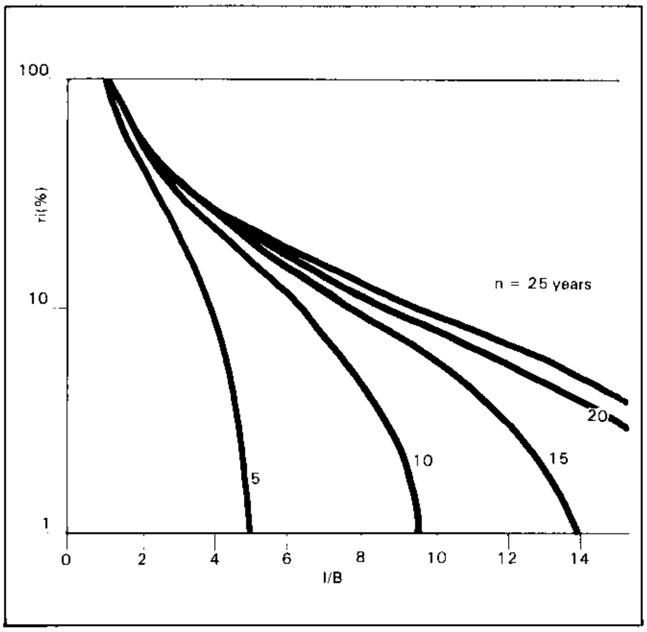


Figure One: *Internal rate of return as a function of the ratio of the investment cost and the annual saving for different values of the useful life* n.

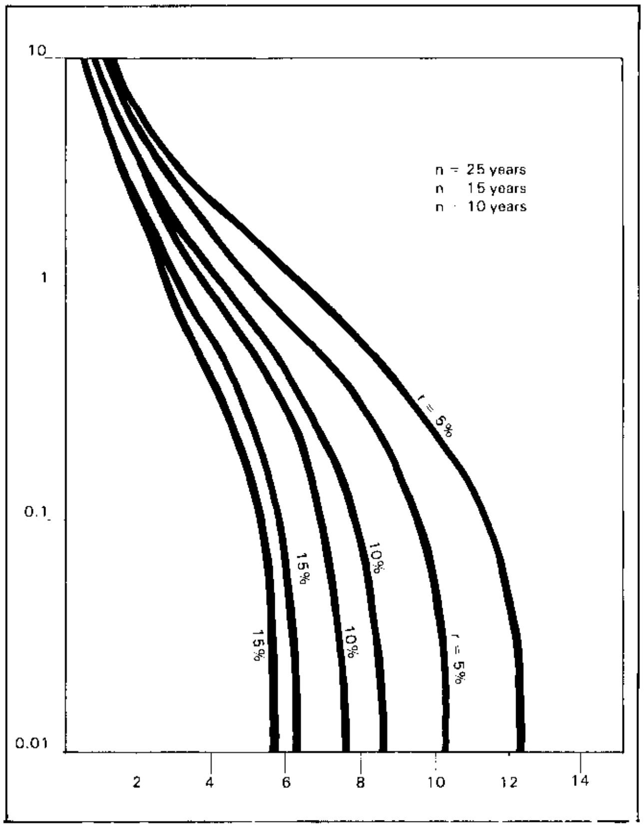


Figure Two: Present-valve ratio as a function of the ratio of the investment cost to the annual saving for different values of the useful life n *and the accounting interest rate* $^r r$.

versus fuel savings in a profitability and pay back situation, aids in the form of computer programs, charts and tables are readily available to facilitate the calculations.

One of the usual methods employed for normal investment calculations can be used — the present-value method, annuity method, internal rate of return method or pay-off method. Such calculations should be in fixed monetary terms.

In addition, special methods for calculating the cost savings have been developed for comparison between different energy-saving methods. In comparison of profitabilities of different saving methods, the specific investment cost can also be specified for saving one kWh/year.

The four standard methods for profitability calculations above give different criteria for assessing profitability of the heat recovery system. However, certain relationships exist between the results obtained in accordance with these methods. If the residual value is zero and, for instance, the pay-off time $^t p$ is known, as defined by

$$^t p = 1/B$$

where *I* is the investment cost and *B* is the annual saving, the internal rate of return $^r r$ can be calculated from the expression

$$\frac{1 - (1 + {}^r i)^{-n}}{{}^r i} = \frac{I}{B}$$

Figure One shows how the internal rate of return varies with *1/B* for a number of different values of the useful life *n*. Similarly, Figure Two shows that the present-value ratio $^V N'$ i.e. the ratio of the present value of the investment to the investment cost, can be determined on the basis of knowledge of the pay-off time, useful life and the real accounting rate of interest $^r r$. (The present value of the investment is the present value of all annual savings minus the investment cost).

In view of the lower installation cost, a heat recovery system is more profitable in a new building that in an existing building, and it is not uncommon for the pay-off time of an installation in a new building to be below two years which, at a useful life of 10 years, corresponds to an internal rate of return of 47 per cent. In profitablity calculations aimed at comparing a heat recovery system with other types of investments, the present-value method should preferably be used, and the results can then be specified as the present value or the present-value ratio. On the other hand, if the calculation is merely intended for checking that a system offers good profitability, the annual saving can be calculated in accordance with the annuity method, and this is considered to lead to a result which is more easy to interpret.

The calculated profitability of a heat recovery system is also dependent on whether or not consideration has been given to future increases in the cost of energy. Profitability calculations for heat recovery systems have so far usually been based on the cost of energy prevailing at the time of installation. Bearing in mind the developments in the field of energy in recent years, there is no reason to assume that a calculation which takes into account a certain real increase in the cost of energy will provide a more realistic comparison.

Bearing in mind the developments in the field of energy in recent years, there is no reason to assume that a calculation which takes into account a certain real increase in the cost of energy will provide a more realistic comparison. As a result any measures which can produce savings should be considered.

If the installation of heat recovery systems can achieve savings in energy costs in could mean application of more funds within the same budget to the real purpose of a hospital — medical care.

The author is a Regional Quantity Surveyor with the Oxford RHA. He first presented this article as a paper at the Institute's Annual Conference at Stratford upon Avon in May Last year.

Joint Venture Tendering

C G HOWARD FRICS

Introduction

The underlying theme of this article is 'the implication of the form of contract on the client and his advisers'. In taking up this theme it is assumed, of course, that the client's advisers have the same aims and objectives as the client!

The objectives of the client when he sets out on a construction project are, primarily, the achievement of a building completed to a good standard of workmanship, on time and within budget cost.

Controls

What controls can the client exert in the building process to achieve these objectives? Simply, they are by choosing good consultants and contractors with known performance, and also by arranging suitable conditions of contract tailored to the need of the project which the parties can operate sensibly. It can be said that the client's advisers in the construction field have often served the client's interests none too well in this respect. Contractors have not been given the tools, in the form of information, to build, and indeed in many cases nor have they been given a sensible basis for working arrangements in the form of suitable contractual conditions. At the same time contractors have not served the client's interests too well because by accepting this unsatisfactory state of affairs the inefficient contractor can exploit the conditions of contract favourable to him in order to mitigate his loss. Whilst one must uphold Standing Orders, DHSS edicts regarding contractual arrangements, and the sanctity of public accountability, it is obvious that these controls are static and are not sensitive enough to changing circumstances. For example, does it make sense for Standing Orders to insist that the contract conditions should be the same for a small housing scheme as for a large multi-million pound hospital development?

Present arrangements

Let us look at the traditional contractual arrangements for a large hospital development having a substantial services engineering element (say over 35% of the Works cost). The extent of the contractor's knowledge of these engineering services when he submits his bid is usually only a PC Sum in the Bills of Quantities. It is on this basis he commits himself to the client to perform the contract to a price and within a given period.

The analogy of an arranged marriage to describe the nomination process is well known. With no knowledge of the nature and content of the engineering services element the contractor must make assumptions regarding the programme for this element when submitting his tender. So, therefore, when he meets the respective engineering services subcontractors following nomination they are more or less forced to fit into the main contractor's programme as best they can. The contractor can, of course, object to the nomination under the '63 Form of Contract, but this right is rarely exercised and some form of patching of the programme and working arrangements takes place. The problem is mitigated to some extent in the 1980 Form whereby the notice of nomination is only preliminary and there is a facility for the main contractor and sub-contractors to get together to iron out problems such as programming, working arrangements.

The building team, and team it must be to carry through a complex building operation such as a hospital, is therefore put together without the services sub-contractor having the ability to influence in any way the overall building process. By putting together the team so late any changes which the sub-contractor may wish to make may not be accommodated as they may not accord with the main contractor's assumptions referred to earlier regarding management and programming, which he was forced to make when submitting his tender.

Risk

In the situation described, a large hospital development with a substantial services engineering element, what are the risks taken by the parties concerned? The contractor and sub-contractors when tendering must price for the risk they will subsequently take for working with unknown contractors. The risk allowance they will make when tendering will be higher for services sub-contractors as their work forms a vital integrated part of the building process. Poor performance by the main contractor and the service subcontractor carries a penalty by reducing profit margins, should this allowance not be sufficient.

The client's risk falls from the conditions of the Standard Form of Building Contract. The tendency has been over the years in developing these conditions for the risks to be taken off the contractor and placed with the client. For example, information and instructions must now be precise. All variations and errors will be paid for by the client.

In the context of this article the client is at risk should the services sub-contractor cause delay to the contract as he, the client is forced to forego the levying of any damages for the period of this delay.

How can the client create a contractual platform for a better performance on site, and also aim to achieve better tenders resulting from the elimination of the uncertainties and risks inherent in the bidding process described above?

A solution is to elevate the role of the services contractors so they have an equal voice at the earliest stage by means of joint venture tendering.

The Oxford RHA has accepted the lines of reasoning given and a description of their experiment follows.

Background

In common with a number of other Regions, Oxford inherited in 1974 a large teaching hospital in course of construction. Also in common with other Regions it soon found the contract was getting out of control, so early in 1976 the RHA set up a member-led Working Party to investigate and report. In course of their investigations nine other schemes having time and cost overruns were considered. The Working Party's report, published in October 1976, recommended, inter-alia, the adoption of consortium tendering for an experimental period.

Although the Working Party was told of the lack of enthusiasm of the Local Builders' Federation, and the claim put forward at that time that the client might not obtain the financial advantage of the combination of the lowest main and sub-tenders, it accepted the advantages put before it. These were generally in line with the thesis put earlier in this paper. Having been investigating time and cost overruns. I am sure the Working Party was also influenced by the fact that no longer could the contract period be extended on account of delay, or alleged delay, on the part of the services contractors.

Experience

In the past six years the ORHA has let some eighteen contracts totalling over £20m at present day values on a joint venture basis. Whilst it cannot be said all of these schemes were built on time and within cost, time and cost overruns have, however, been kept within acceptable limits. This improvement may be derived from the Certificate of Readiness to Proceed to Tender procedure and the more competitive situation which has existed in the industry over the last few years. It may also be due to the three main contractors having a mutual stake in a successful contract.

Policy

Initially the policy of the RHA was to use JVT on the majority of schemes, in some cases even on schemes costing less that £$^{1}/_{4}$m. Difficulty was experienced in forming tender lists as the kind of contractors used for these smaller size schemes knew very little of what they were about. In any case, it is not on these schemes the real problems occur. Our policy now and in the future will be to use JVT on schemes with a lower marker of £1m, and then only when the services element is a substantial part of the whole.

Selection

Selection of tenderers was, in the early days, by means of the initial invitation to building contractors asking if they wish to tender on a joint venture basis, and if so to name their partners. This often posed a problem in that the proposed services partners are not always on the Authority's approved list, and precious time had to be taken in order to vet the new applicants. The method of selection has also been reviewed. The Regional Engineer's concern that he has lost the initiative in selecting the services contractors is now recognised. Also it could be argued that by going to the building contractor initially, asking him to nominate his partners, the 'big brother' approach was being perpetuated. This is against the spirit of joint venture, and as is well-known, is a cause of concern to CASEC. Now and in future, therefore, the ORHA is giving the mechanical and electrical contractors an opportunity of naming partners as well as the building contractor.

Tendering

The joint venture proposal is described in the letter of enquiry to tenderers and a declaration is obtained from all parties to the joint tender. In addition, because of representations from the NJCC that all parties may not appreciate the full implications of a joint venture and because, as officers in the Public Service have a moral obligation, a warning clause is inserted. This clause spells out the legal liability of each party to perform the entire contract and advises them to consider arrangements for their mutual protection. Tenderers are not instructed to insure against their risks or indeed what arrangements they should make. Lines of communications are sorted out at the time of the initial enquiry, but the mechanics of payment, ie the name of the payee, are settled when accepting the tender.

Contract

Legal advice given five years ago, and confirmed again last year was that in no way should the RHA become involved in any partnership arrangement between the building and engineering contractors.

How they agree the profits and liabilities between themselves is entirely up to them. The Authority has not, therefore, concerned itself with the mechanics of how the parties sort out their mutual responsibility regarding, say insurances, VAT, remedying defects, etc.

The only amendment made to the Standard Form of Building Contract is to define the contractor in the Articles of Agreement as the name parties who shall be jointly and severally liable for all the obligations of the contractor contained in the Agreement.

DHSS

The DHSS has, of course, shown considerable interest in JVT. Views have been exchanged and discussions have taken place. They regard JVT arrangements as an unconventional form of tendering in the NHS and, therefore, approval to its use must be sought. They are, however, quite open-minded on the matter and have asked that an appraisal be made over, say, the next five years of our experiences in using JVT and of other contracts using conventional arrangements.

Benefits

It has been said that the client is paying a penalty when JVT is used in that he is not benefitting from the lowest combination of tenders. This claim is difficult indeed impossible to prove in that the tenders themselves may be keener because of the greater degree of certainty on the part of the three contractors; also, one is unable to know positively if one is comparing like with like in that the share of common preliminary items between the constituent tenders may not be the same in all cases. In any case, experience has shown the arithmetical results to be a 'penalty' of 1.61%, which is littlemore than the tangible saving from avoiding nominated subcontractors' discount and profit.

It is, therefore, very difficult to give a quantitive assessment of the cost benefits to be derived from using JVT. RHA officers, having learned from their experiences and their mistakes, are satisfied that the course now set should result in improved performance from contractors. It is axiomatic that cost benefit should fall to the client. Perhaps the appraisal referred to earlier will answer this hypothesis.

Product News

Saving energy at Leicester Hospitals

Since the installation of Transmitton's Micropower 100 system at Groby Road Hospital, Leicester, the District Health Authority report savings of between £30,000 and £35,000. The first phase of the system was installed in 1981 to control and monitor the main boiler house, laundry and operating theatres.

District Works Officer, Gordon Pidcock, said, "Transmitton's Micropower 100 helps us to implement tighter controls over the energy we use as well as maintaining critical environmental conditions in the three main operating theatres. This is absolutely vital, as the cardiothoratic surgery we perform here can often extend over long periods.

Our boiler plant, consists of three economic steam boilers rated at 21,000 lbs per hour, producing steam at 150 psig. These boilers provide the total heating requirements for Groby Road Hospital and the main District laundry.

Controlling the operation of the District laundry itself is another major area of saving. It processes over 100 tons of laundry per week. Control of the steam supply to this department is via an automatically operated steam valve. Micropower 100 opens the valve ready for the start of each shift and closes it down immediately the shift finishes. This operation alone saves over £7,000 per year".

The Micropower system consists of a central station wth keyboard, printer and VDU, linked by a 4 core transmission line to five out-stations located around the hospital site. The ultimate capacity of the system is eighty four outstations. Each outstation has a number of analogue and digital inputs and outputs to monitor and control local plant and equipment.

For further information contact: Mr W Watson, Transmitton Ltd, Smisby Road Ashby-de-la-Zouch, Leicestershire LE6 5UG. Tel: Ashby-de-la-Zouch 415941.

Coal handling system

The move from oil back to coal as a fuel in today's industry does not mean the return to its associations of the past with dirt and hard labour.

Illustrating the point, BIVAC division of DD Lamson have launched Transflo, a complete system for handling coal, ash, grit or similar substances.

Offered either as a complete unit or as two distinct systems (Lean Phase and Dense Phase), the TRANSFLO is capable of handling graded coal — doubles 25–50mm (1in. - 2ins.) or singles 12–25mm (1/2 in.) and ungraded coal and washed smalls — 12 mm (1/2 in.) pieces downwards — which have a high level of dust.

All Transflo systems can be fully automated and are controlled from a central console where the coal feed is monitored and boiler surge hoppers are automatically fed to ensure a continuing flow of coal to the boilers.

Ash is automatically removed from each boiler and from the grit arrestors under controlled conditions — the lean phase system, adapted for ash removal, is controlled from a central timer and ensures that each ashpan is emptied on a timed sequence basis.

Prior to discharge, ash tray may be conditioned so that both ash and grit are removed with a minimum of nuisance when gravity fed into an open receptacle or vehicle.

Further information from: D. D. Lamson Ltd, Harbour Road, Gosport, Hampshire, PO12 1BG. Telephone: 070 17 84271.

Normal/Emergency luminaire conversion kits

Chloride Standby Systems Ltd has introduced two new emergency lighting conversion kits to convert conventional fluorescent lights into dual function normal/emergency luminaires.

The Bardic CC65 and BC85 kits provide up to three hours' emergency illumination, and both work with the new narrow fluorescent tubes.

The CC65 is a conversion kit designed for flourescent tubes up to 58/65 Watts. It consists of a conversion module (which contains static inverter, changeover relay and charger), a battery pack of six high-temperature, sealed nickel cadmium cells, and a push-fit LED indicator.

The larger BC85 kit is suitable for fluorescent tubes up to 70/85 Watts, and if a two-hour duration is acceptable can be used with 100/125 Watt tubes. The conversion module complies with ICEL 1001, and the battery pack consists of 10 cells.

In both cases, the conversion kits do not interfere with the fluorescent light's normal operation. The flourescent lamp is still operated by the existing circuit, switched as required. The battery charger in the conversion kit is powered by a separate unswitched AC supply. If the AC mains supply fails, the conversion module disconnects and isolates the normal control gear and connects the static inverter output to the lamp.

An LED indicator, which can be positioned for optimum visibility, shows AC supply healthy, charger operating and battery connected. Both conversion modules incorporate a constant current charger.

The new Bardic conversion kits will be marketed via Chloride Standby's UK network of 150 stocklists.

Further information from Chloride Standby Systems Limited, William Street, Southampton. Telephone: 0703 30611.

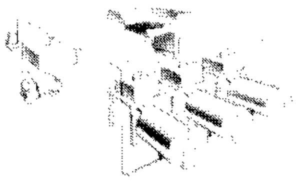
'Clear' message for vandals

Prodorite Limited is continuing its development of wall coatings to beat the efforts of graffiti vandals and has recently launched Prodorfilm anti-graffiti clear coating which the makers claim is an effective barrier against the graffiti vandals' armoury. Designed for a wide range of surface textures including York stone, brickwork, concrete, cement, emulsion surfaces, masonry and gloss paint, in trials in the West Midlands, test areas have been subjected to a wide range of markers, spray paints and pens. The graffiti is easily removed from the test areas with the use of a standard graffiti spray cleaner and a soft rag. Results from corresponding untreated areas however left behind unsightly smudges.

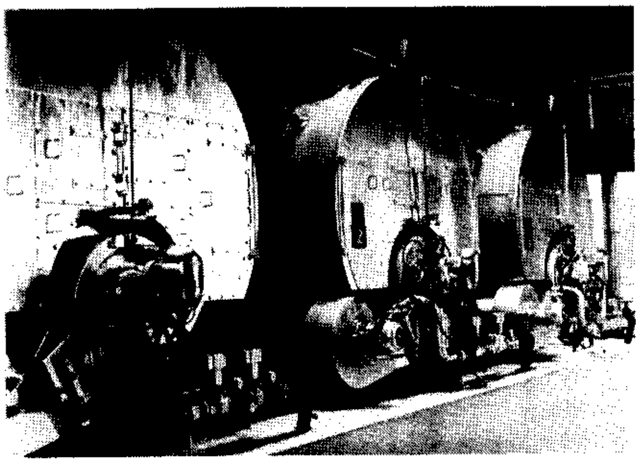
Prodorfilm anti-graffiti clear coating is designed to give high durability and resistance to abrasion, weather resistance, and does not allow penetration of marker inks or paints. Moreover, it seals against atmospheric corrosion and does not support mould or bacterial growth.

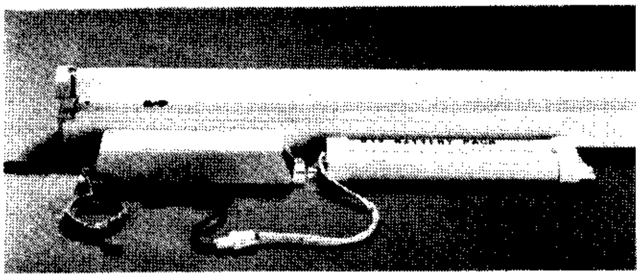
To complete its service to beat the vandals, Prodorite has available a cleaner solvent spray which effectively cleans off graffiti from walls treated with its Prodorfilm anti-graffiti coating.

For further information please contact Prodorite Ltd., Eagle Works, Wednesbury, West Midlands WS10 7LT.

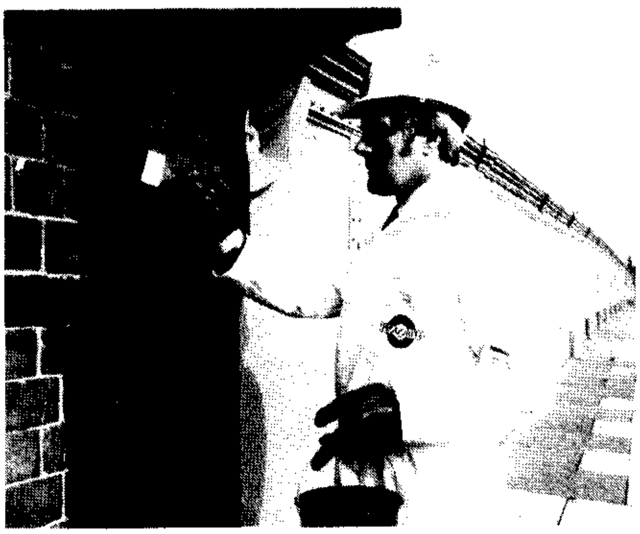


Coal feed and ash removal system.
Transmitton's boiler controls.





Emergency Luminaire Conversion kit.
Anti-graffiti clear coating.



Classified Advertisements

APPOINTMENTS AND SITUATIONS VACANT

West Dorset
Health Authority

SENIOR ENGINEER

(Male/Female)

Salary scale £7,231 rising to £8,370 per annum plus 15% bonus scheme allowance, required for the Herrison Works Section, which is a large psychiatric hospital. Applicants should have completed an apprenticeship in mechanical or electrical engineering.

A minimum qualification of HNC in Engineering required or an appropriate equivalent as laid down by the Department of Health and Social Security. Candidates must have experience in management of mechanical/electrical plant, up-to-date maintenance planning, control and deployment of staff, also a flair for administration.

For further information and job description, contact the District Works Department, Damers Road, Dorchester, Dorset. Tel: (0305) 63123 Ext. 311. Closing date 14 days after the appearance of this advertisement.

Previous applicants need not re-apply.

District Works Officer

Salary on scale (DT3):-
£18,698 — £22,570 per annum inclusive.

Applications are invited from senior works professionals for this challenging and rewarding post, based at The Royal Free Hospital in this London Teaching District.

The successful applicant (male/female) will be responsible to the Authority for the management of an integrated, professional service including all building and engineering work and estate management. The ability to demonstrate good managerial and professional experience is essential, particularly the maintenance of building/engineering operations in the NHS.

In addition to possessing the necessary qualifications and experience, applicants should be currently graded Area Works Officer, Area Engineer, Area Building Officer or District Works Officer.

Candidates wishing to discuss the post are welcome to telephone the District Administrator, Mr. N. Walton or the District Works Officer, Mr J. Sancroft on 01 794 0500.

Application form and job description are available from the District Personnel Department, Hampstead Health Authority, Royal Free Hospital, Pond Street, London NW3. 01-794 0500 ext. 4286. Closing date for returned applications: 28th April, 1983.

HAMPSTEAD
HEALTH AUTHORITY

South West Thames Regional Health Authority
Engineer's Division

Sterilizer Technician Engineer

(Grade TA I or TA II dependant on qualifications and experience).
Salary Scale TA I : £7,453 - £8,791
TA II : £6,644 - £7,416
Plus £149 p.a London Weighting.

To carry out surveys and inspections, and prepare reports and validation records on new and existing sterilizer installations within the Region. Training will be provided where appropriate.

The post is based at Guildford, but as extensive travelling within the Region is an integral part of the job, applicants (male/female) should own a car and hold a clean current driving licence.

Application form and job description available from: Headquarters Personnel Officer, South West Thames Regional Health Authority, 40 Eastbourne Terrace, London W2 3QR. Tel: 01-262 8011 ext. 69. For an informal discussion, please phone Mr. Tom Jones, Telephone 01-262 8011 ext. 432.

Closing date: 15th April 1983.

Basingstoke and North Hampshire Health Authority

Basingstoke District Hospital

Electrical Engineer

£8,385 - £9,458 (incl. 15% bonus)

In this interesting and rewarding position, you would be part of the Works Department team based at Park Prewett Hospital in the Basingstoke District Hospital complex — set in a 255-acre park just outside the town.

You would be accountable to the Senior Engineer for management of a day-to-day maintenance team and minor new works and up-grading schemes.

Since Park Prewett Hospital houses over 750 patients, plus the District Laundry (85,000 items a week), central automated Boiler House (75,000 lbs/hr at 120psi) and its own stand-by power generators (550 Kva), you will need a wide range of electrical trade knowledge.

Applicants should have a friendly nature and a high degree of versatility, for the position promises "never a dull moment". You must also be qualified to a minimum of ONC Tec II level, and have some experience of site services.

To obtain a job description and application form, please contact Mr E. Feasey, Unit Works Officer, Psychiatric Division, Basingstoke District Hospital, Basingstoke Hants RG24 9NA. Telephone Basingstoke 3203, extension 251 or 413. (Informal discussions before applying are welcomed).

Please quote reference HE15/1493. Closing date: 29th April, 1983.

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