HOSPITAL ENGINEERING

January/February 1977

The Journal of the Institute of Hospital Engineering

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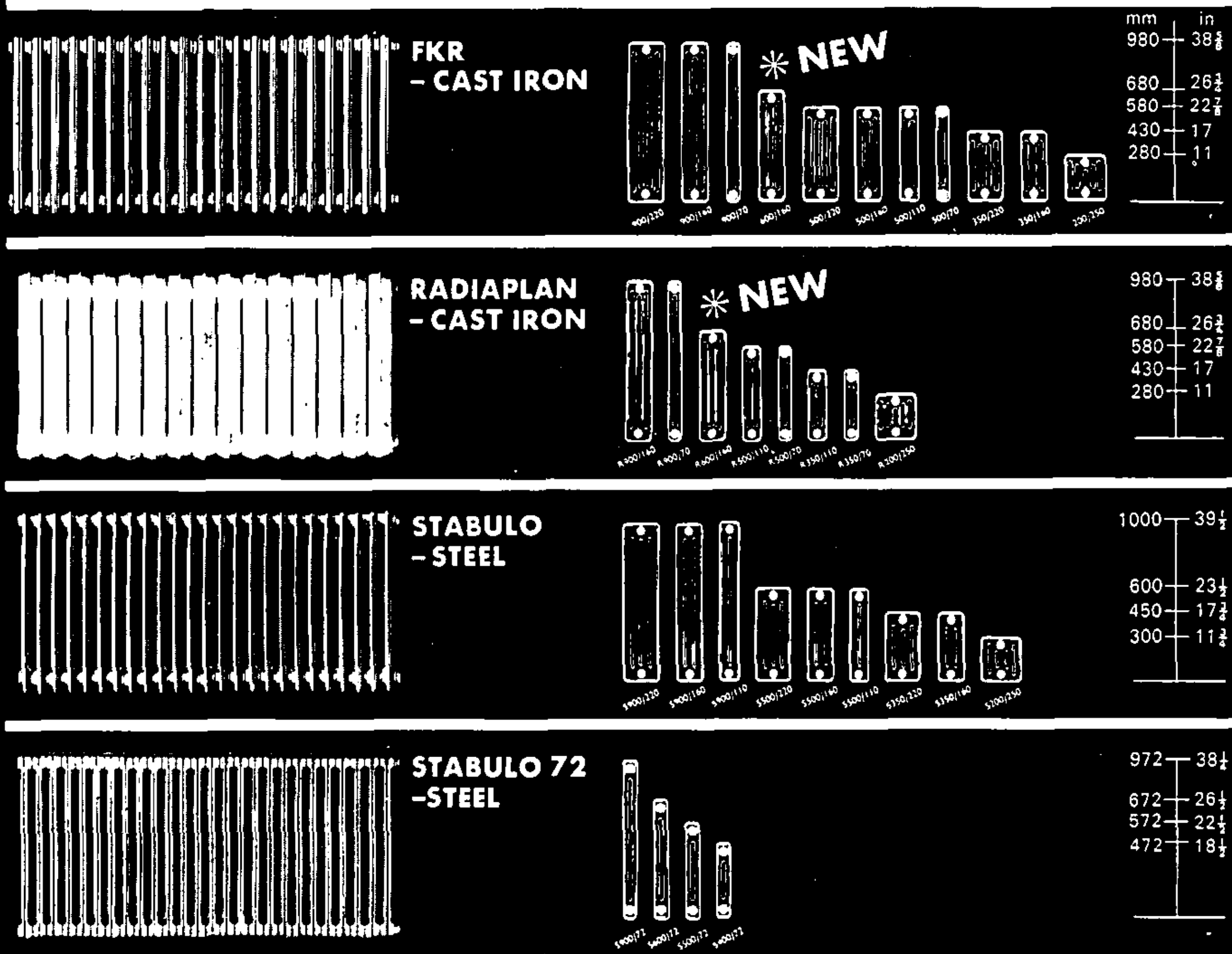

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HOSPITAL ENGINEERING

January/February 1977 **Vol. 31 No. 1**

The Journal of the Institute of Hospital Engineering

Contents

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

Editorial

This issue of *Hospital Engineering* marks the beginning of the second phase of the new publisher's efforts to improve the Journal, to make it more readable, and to give readers relevant information as soon as possible as it becomes available.

It appears at the beginning of a year which could be very significant in the development of the National Health Service — a development for which all the signs are not encouraging. The medical profession have aired a suggestion that patients should pay fees based on their use of the Service. Dr. David Ennals has turned the suggestion down flat, and has warned that those operating the Service must make do on the funds that they have.

This is a worrying situation for all those who have the welfare and morale of the NHS at heart. And turning to morale, it is only too clear that this is at a low ebb. A box number advertisement in our December issue offering tax-free posts in a new hospital overseas received well over eighty replies — some five per cent of the total membership of the Institute. It is a sad reflection on the atmosphere of doubt and uncertainty in which many people carry out their daily work today — we hope that our editorial in our first issue for 1978 will be able to strike a happier note.

On thing that will help is better communication. We would be delighted to receive, for publication or otherwise, readers' comments on the situation, and their suggestions as to the way in which the NHS should develop. Members' views are also being sought by the Institute for submission to the Royal Commission on the NHS — details are given on this page.

Institute News

The New President

Mr. J. Richard Harrison CBE

Richard Harrison will become President of the Institute at the Annual Conference at Pitlochry in April. He has had a most distinguished career in engineering, and is evidently eager to get to grips with his new task, for which his recent retirement from full-time practice as a consulting engineer will give him enough time — although a more energetic retirement than Mr. Harrison's is hard to imagine!

Born in Hull in 1910, Mr. Harrison has lived most of his life in London. Educated at Christ's Hospital and the City and Guilds' Engineering College, he graduated in 1931.

After a pupillage under Dr. Oscar Faber he worked as a structural engineer in the same firm, transferring in 1936 to the Building Services side of the practice. The war years were spent on Ordnance Depots and other industrial work, and in 1944 he was put in charge of the Building Services for the rebuilding of the House of Commons.

In 1951, he joined J. Roger Preston and Partners as Chief Engineer, becoming a partner in 1954, and was Senior Partner from 1966 until he retired from the partnership and became Consultant to the partnership in 1975. The firm, which celebrated its Golden Jubilee in 1976, has always been much concerned with hospital work, the first major post-war project being Princess Margaret Hospital at Swindon. The firm was also involved in the development of some of the Harness standard design.

Mr. Harrison has had a long association with the Institution of Heating and Ventilating Engineers (now CIBS) becoming its President in 1963. He was Chairman of its Guide Committee for the 1965 edition, and has served on BSI and other committees. He has also been much concerned with the Association of Consulting Engineers, of which he was Chairman in 1973-74.

He is a Chartered Engineer in the UK, and a Registered Engineer in New Zealand, and has travelled extensively for the firm in the Middle East and the Far East particularly in connection with the sister firm in Hong Kong of which he is a partner.

He was honoured in 1974 by the award of a CBE, for his work in the hospital field.

Mr. Harrison and his wife live at Bickley in Kent. Here, since his retirement as Senior Partner of J. Roger Preston and Partners, he does quite a lot of the consulting work that he still carries out for the firm. This includes a technical information service of extracting material from many profeessional publications for regular circulation within the firm, an activity which keeps him very much up to date — which is most apparently what he has always been.

Mr. Harrison does not believe in doing things by halves — a product no doubt both of his inherent character and also of his early practical engineering training. He still enjoys precision work, and modestly reckons himself to be a pretty fair fitter. Certainly, he has had his ten year old Jaguar motor car to pieces at least once, and much enjoys working with wood, both for practical purposes and for the pleasure of handling the material, and turning its own characteristics to best use.

He is also a gardner, in an interesting and perhaps unusual way. Not over-keen on general gardening, he became interested largely by chance just after the war in tall bearded irises. Not surprisingly, he has made himself an expert in them, and experiments with raising new strains, finding the complex business of plant genetics a source of fascination — truly an engineer's approach to a subject! Another interest is the local golf club, where Mr. Harrison plays his part as a committee member with obvious pleasure, supporting his club whenever he can, and enjoying its social functions.

As an engineer virtually from birth — he is the fourth generation of his family to be one — and by his own great experience, especially of hospital work, Mr. Harrison is eminently well qualified for his new task. We wish him every success in his term of office.

Royal Commission on the NHS

As members will know, the Institute is offering a written submission to the Royal Commission on the National Health Service.

Even at this late hour, the invitation to individual members or groups of members is repeated, that they should offer their comments for the consideration of the Working Party preparing the Institute's submission.

Please send any comments direct to

the Chairman of the working party: K. J. Eatwell OBE, Regional Engineer, South West Thames RHA, 40 Eastbourne Terrace, London W2 3QR.

New Year's Honours List

Our congratulations to Alec Wotherspoon, OBE, Assistant Chief Engineer, Scottish Development Department; and George Tuson, MBE, Assistant Regional Engineer, Wessex Regional Health Authority on their inclusion in the New Year's Honours List.

The Falfield 'Keele' Courses – 1977

The dates of this year's National Post-Experience Courses in Engineering Management are:
Course K3 — 10 to 15 July
Course K4 — 18 to 23 September

All information relevant to the Course's may be obtained from: The Principal, NHS Hospital Engineering Centre, Eastwood Park, Falfield, Wotton-under-Edge, Glos. GL12 8DA.

Our December Issue

Readers may well have noticed the effects of one or two attacks of the well known gremlins that haunt publications from time to time. The most apparent was in our mention of the Institute's forthcoming annual conference at Pitlochry, where three lines of type which should have appeared at the end of paragraph 1 got above themselves, literally, and intruded above the correct start of the paragraph. It is hoped that this stating of conclusions before the facts from which they were drawn did not cause too much anxiety! More serious, if less readily apparent were the delays in production and in the post which caused some copies to reach readers only just before Christmas. These were caused originally by the late provision of one of the main articles in the issue, which held up publication by a few days. Most unfortunately, thereafter, the Christmas post took a hand, and some copies took nearly two weeks to reach their destinations. Monthly magazines enjoy no special postal treatment, unlike newspapers and many weeklies, and it seems that *Hospital Engineering* was particularly unlucky this time. We mention this particularly for the benefit of those recruitment advertisers who set closing dates only a few days after the planned publication date of the issue.

Annual Conference

Pitlochry, April 27 to 29

By now members should have received direct from the Institute all details of the annual conference. Non-members are of course welcome to attend, and should contact the Secretary of the Institute at 20 Landport Terrace, Southsea PO1 2RG as quickly as possible. The programme is given below:

Wednesday, April 27

10.15 a.m. OFFICIAL OPENING of the Conference by
F. H. HOWORTH F.R.S.A., F.Inst.P.I., F.I.I.C., F.I.Hosp.E.,
President, The Institute of Hospital Engineering

10.30 a.m. 'THE DHSS HEALTH BUILDING SYSTEM'
'The System as a Whole'
Speaker: S. RATCLIFFE, C.Eng., M.I.C.E., M.I.Mech.E., M.I.H.V.E., M.I.Mar.E.

11.30 a.m. 'Its Engineering Components with particular reference to the Design and Commissioning of Sub-Systems'
Speaker: B. C. OLIVER, C.Eng., M.I.Mech.E., M.Inst.R.

2.30 p.m. 'The Maintenance and Operation of Sub-Systems'
Speaker: R. J. TUTHILL, C.Eng., M.I.Mech.E., M.I.Prod.E.

3.30 p.m. 'Specialist Services'
Speaker: A. C. SELMAN, M.Sc., C.Eng., M.I.Mech.E.
Chairman for the day:
JOHN BOLTON., Ll.B.(Lond.), C.Eng., F.I.C.E., F.I.Mech.E., F.Inst.F., Hon.M.I.Hosp.E., F.R.S.H., F.I.Arb.

Thursday, April 28

10.30 a.m. 'PAISLEY DISTRICT GENERAL HOSPITAL
THE USE OF AN INDUSTRIALISED BUILDING SYSTEM'
Speakers: W. N. BEWICK, F.C.I.B.S., M.Cons.E., F.I.Hosp.E.,
R. W. Gregory & Partners
G. L. BRUCE, D.A.(Edin.), A.R.I.B.A., A.R.I.A.S.,
Baxter Clark & Paul
J. MacFARLANE, F.R.I.C.S.,
D. M. Doig & Smith
E. R. MASON, B.Sc., C.Eng., F.I.C.E., M.Cons.E.,
T. Harley Haddow & Partners
Chairman: B. P. BECKETT, B.Arch., D.I.P.T.P., F.R.I.B.A., F.R.I.A.S., F.R.T.P.I., M.I.A.,
Chief Architect, Scottish Development Department

2.30 p.m. 'COMPUTER AIDED DESIGN AND OPERATION OF HOSPITALS'
'Computer Modelling of Building Performance'
Speaker: Professor T. W. MAVER, B.Sc., Ph.D., M.I.H.V.E.,
Director, Architecture and Building Aids Computer Unit, University of Strathclyde
'PHASE: A Computer Model for Building Design and Operation'
Speaker: R. WALTERS, B.Arch.(Honours), M.Sc., R.I.B.A.
'PHASE: Its Use in Practice'
Speaker: D. KERNOHAN, B.Arch.(Honours), M.Sc., R.I.B.A.
'ESP: Developments in Environmental Systems Performance'
Speaker: J. CLARKE, B.Sc.(Honours)
Chairman: T. D. W. ASTORGA, D.A., Dip.T.P., R.I.B.A., F.R.I.A.S., F.I.O.B.,
Director, Scottish Health Services Common Services Agency

7.30 p.m. for 8.00 p.m. CONFERENCE DINNER DANCE

Friday, April 29

10.30 a.m. 'THE APPLICATION OF QUANTIFIED RELIABILITY TECHNIQUES TO SYSTEMS USED TO PROVIDE ENVIRONMENTAL CONTROL IN PUBLIC BUILDINGS'
Speaker: L. H. BURGESS, A.M.I.E.E.,
U.K.A.E.A., Systems Reliability Service

Chairman: A. WOTHERSPOON, O.B.E., C.Eng., M.I.C.E., F.I.Mech.E., M.I.E.E., Assistant Chief Engineer, Scottish Development Department

12.15 p.m. CONFERENCE CLOSURE by THE PRESIDENT, THE INSTITUTE OF HOSPITAL ENGINEERING

Apart from the formal proceedings mentioned above, there is also a full programme for those ladies attending who are not concerned with the technical aspects of the conference. This includes visits to a distillery and a tweed mill, a coach tour to Killiecrankie, Blair Castle and Loch Tummol and another mystery tour (of which the one thing known is that lunch is provided), and a visit to the Pitlochry Festival Theatre. There is of course also the Conference Dinner Dance, to which it is hoped that those delegates who have not enjoyed the hectic social programme outlined above will be allowed to escape.

Another feature of the conference will be the Institute's Annual General Meeting, at which the new President will assume office.

The Institute of Hospital Engineering One-Day Symposium

Transport in the National Health Service

to be held at The Institution of Electrical Engineers, 2 Savoy Place, Victoria Embankment, London WC2, on Wednesday, March 2, 1977

In relation to transport in the National Health Service, the Symposium will focus attention on the legal responsibilities and show how the operational difficulties in controlling a mixed dispersed fleet are overcome. The engineers' role in satisfying the legal and operational needs will be discussed and there will be a review of the financial implications. Chairman: JOHN BOLTON Esq., LL.B.(Lond.), C.Eng., F.I.C.E., F.I.Mech.E., F.Inst.F., Hon.M.I.Hosp.E., F.R.S.H., F.I.Arb., Chief Engineer, Department of Health and Social Security.

10.00 Assembly and Coffee

10.30 'THE LEGAL RESPONSIBILITIES OF OPERATING A FLEET OF VEHICLES'
Speaker: JONATHAN LAWTON Esq., M.A.(Cantab.), Solicitor

11.15 'MANAGING A DISPERSED FLEET OF VEHICLES'
Speaker: T. R. WALTON Esq., F.I.A.O., Chief Officer, London Ambulance Service

11.45 'TRANSPORT ENGINEERING — THE LEGAL AND OPERATIONAL IMPLICATIONS'
Speaker: N. E. H. PETERS Esq., C.Eng., F.I.Mech.E., M.C.I.T., M.I.R.T.E., Automotive Engineer, South West Thames R.H.A.

12.30 LUNCH

14.15 'FINANCIAL ASPECTS OF FLEET OPERATIONS'
Speaker: W. L. GAGE Esq., B.Sc., C.Eng., M.I.Mech.E., M.I.R.T.E., A.M.B.I.M., Professor in Management Studies, Polytechnic of Central London

14.45 OPEN FORUM — Questions and Discussion until 16.00

Tickets available £6 each from the Secretary of the Institute at 20 Landport Terrace, Southsea PO1 2RG.

IEE Lecture

The Engineer, the Patient, the Clinician

The important contribution electronic engineers are making to medical science in both diagnosis and treatment of patients is the theme of a lecture to be given by Dr. John Bushman at the Institution of Electrical Engineers (IEE), on February 17 at 5.30 p.m.

Tickets are available from the IEE at 2 Savoy Place, London WC2, telephone 01-240 1871, to whom any enquiries should be made.

RSH Lecture

Hospital Design for the Medical Supplementary Professions

Members are invited to apply for tickets to this lecture, to be given by Mr. R. H. Goodman, Dip.Arch. (Hons.), R.I.B.A., Chief Architect, Department of Health and Social Security, on Wednesday, March 2 1977, at 6.30 p.m. at the Royal Society of Health Headquarters, 13 Grosvenor Place, London SW1.

Admission to the meeting is free, but by ticket only. Application forms are available from the Society's Conference Department, 13 Grosvenor Place, London SW1X 7EN, telephone 01-235 9961, and must be returned by Monday, February 21 1977.

West of Scotland Branch

Control of Electrical Installations

At a meeting of the Branch held on November 25, 1976 a paper entitled 'Operation of the National Inspection Council for Electrical Installation Contractors (NICEIC)' was given. The speaker was G. D. Sweeney, an Inspecting Engineer with the Council. He explained in general terms that the NICEIC was a non-profit-making organisation who, through their Register or Roll of Contractors, protected the Consumer from inferior quality workmanship by monitoring technical standards. The standard of workmanship of prospective members of the Register was assessed by the Inspecting Engineer who reported back to the Council. Approximately 70% of all applicants were deferred due to minor infringements of the IEE Regulations. A continuous programme of random checks on the work of registered Contractors was also carried out.

Mr. Sweeney explained that Customer complaints were dealt with by Special Inspections. The Council also provided technical advice to Contractors and other interested parties in a quarterly review. Generally speaking, deviations from the Regulations usually involved Part II sections A, B and E. Although the Council maintains a Register of Approved Contractors, direct labour departments of say Local Authorities and the Health Service may also apply to the Council for approval and therefore become subject to regular inspections of workmanship.

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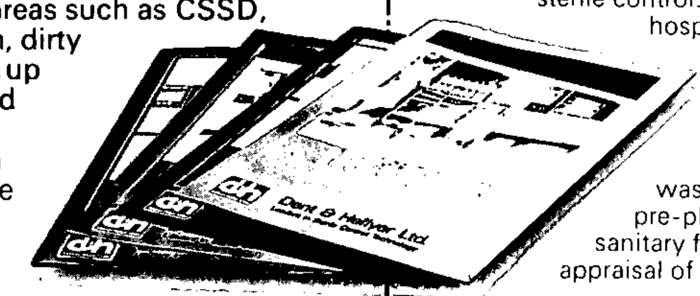

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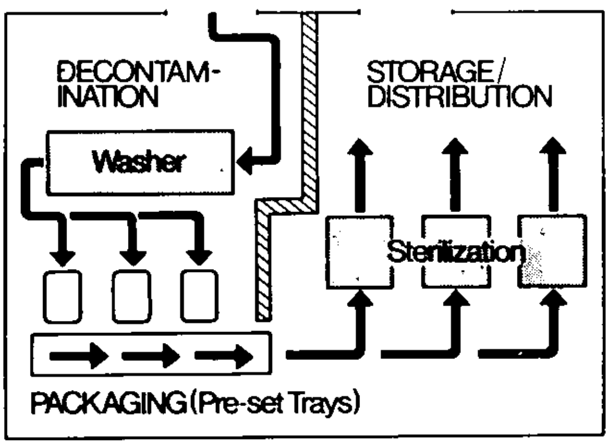

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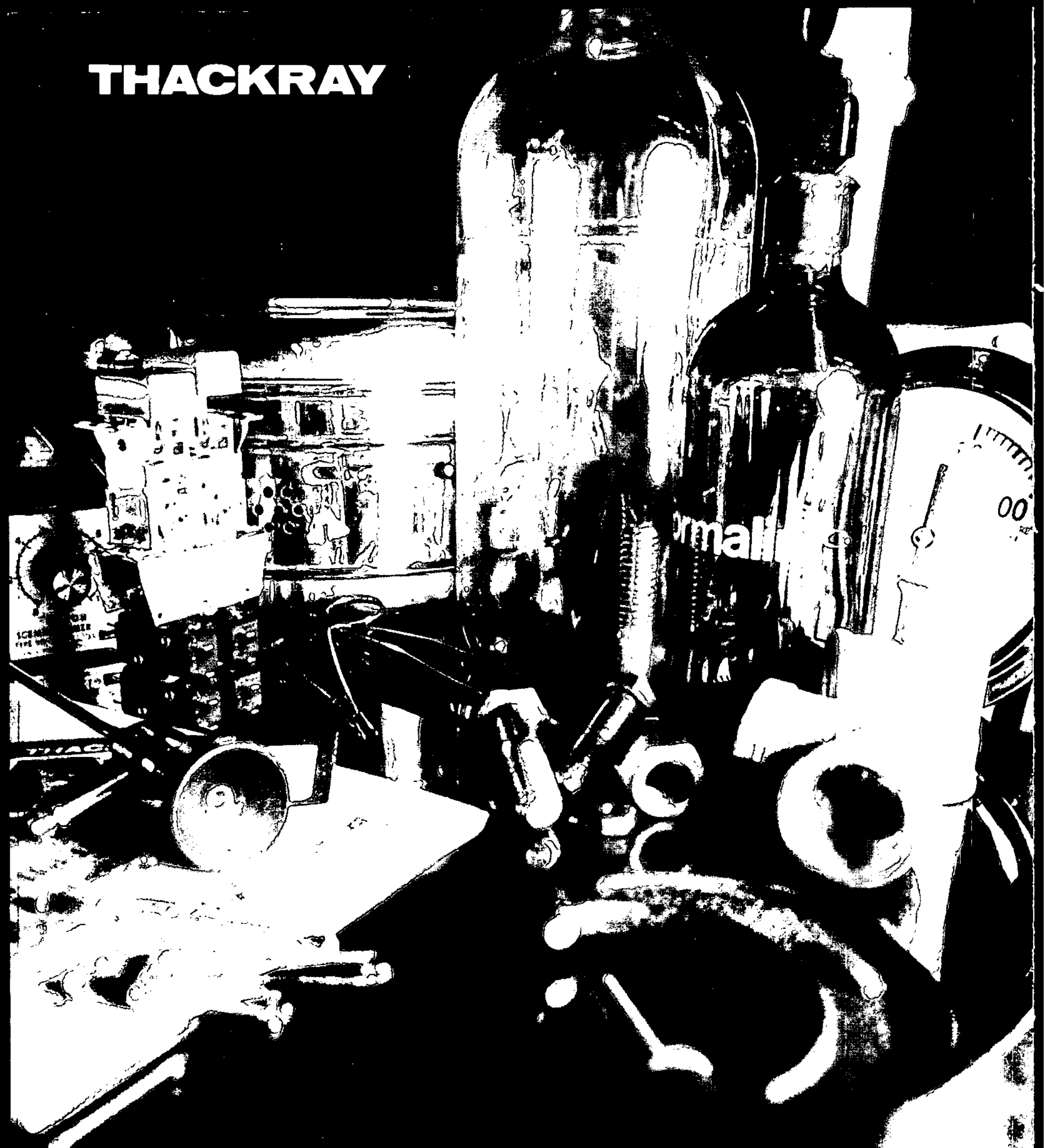
THACKRAY

These three papers are extracted from those given at a conference held at the University of Leeds in September 1976, organised by the Royal Society of Health, and are reprinted with the Society's permission.

Asbestos - Health Hazards in Perspective

Mr. Kelly is Scientific Adviser, Greater London Council.

Asbestos - Constructional Uses

R. T. KELLY MRSH

Despite a considerable amount of literature on asbestos, its uses and its possible effect on health, there is some confusion over the acceptability or otherwise of asbestos-based products. Little common ground exists and possibly only two statements can be made which would have a fair measure of support:

(i) that the different types of asbestos have chemical and physical properties such that they can be incorporated in products whose use has significant advantages;

(ii) that the inhalation of the fibres of different types of asbestos can produce certain diseases.

Two areas of uncertainty emerge from consideration of these —

a. what dosage of asbestos fibres is needed to produce these diseases;

b. whether on balance the benefits to the population as a whole by the use of asbestos products outweigh the disadvantages of their use to certain individuals and groups.

This paper describes the background to the consideration given to these matters by a major local Government Authority.

In mid-1975 the need for specifying alternative materials for constructional uses was considered. On the basis of the information then available, the following advice was given:

(i) that it would be prudent to limit the use of materials containing asbestos to those purposes for which there is no satisfactory substitute;

(ii) that alternatives should be sought for these purposes and substituted as they become available;

(iii) that an assessment of the extent to which blue asbestos had been used in existing building should be made; and

(iv) that an identification should be made of the purposes for which asbestos-based materials had been used — special attention being paid to those applications involving loose asbestos.

Future and Existing Uses

Subsequently, it was agreed that in future the purposes for which asbestos products were regarded as suitable and unsuitable were as indicated in the Appendix. These limitations on future constructional uses of asbestos products raised the question whether such products already used should be left in place.

Two important differences needed to be appreciated between future use of asbestos products and any consideration of the acceptability of leaving those already installed in place. These two differences are:

(i) that because it was understood that crocidolite (blue asbestos) had not been used in the manufacture of materials in Britain since about 1970, only the acceptability in the future of asbestos products containing other forms of asbestos needed to be considered; and

(ii) whilst the information available at that time indicated a level of uncertainty of the acceptability of particular asbestos-based products such that it would be prudent not to use them in the future, this uncertainty could not be taken as indicating that the case for the removal of such products from existing buildings needed additional consideration.

In addition to the need to protect those workers whose occupations are covered by the Asbestos Regulations, there was a need to consider the health risk of:

a. those working in Council and Authority buildings but not dealing with work to which the Regulations apply;

b. those using the buildings, but not working there.

It was therefore decided:

a. to base an initial assessment of whether asbestos products should be left in place in existing buildings on inspection by experienced staff who would ascertain whether there was a danger of asbestos fibres being released into the air; and that

b. air sampling be restricted to:

(i) places such as ceiling voids and ventilation ducts, since it is felt that information from such measurements would augment the information already published by the Asbestos Information Committee on asbestos levels in buildings;

(ii) those areas where a decision on whether asbestos products should be left in place cannot be made by any other means, such as visual examination;

(iii) those areas where, following remedial work or removal of asbestos it is necessary to check whether the air quality is acceptable.

The air quality standards chosen for any air sampling carried out were to be:

(i) that the concentration of blue asbestos present in the air should be not greater than the normal background level;

(ii) that for white asbestos, the 'non-occupational' limit suggested by the Asbestos Information Committee of 0.04 fibres/cc in its publication 'Safety of Buildings Incorporating Asbestos', should be used. However, because it was recognised that this standard could be criticised from several different points of view, it was to be kept under review.

In deciding whether treatment of or removal of asbestos products containing white asbestos was necessary such factors as: the nature of the material; situation; vulnerability to damage or exposure by rough use, or vandalism or maintenance work; and the nature of the occupancy of the building, had to be taken into account. With blue asbestos it was decided that unless it was well protected, it would be removed.

New Considerations

In such a rapidly developing situation, not surprisingly even in the comparatively short time since these decisions were made, important new considerations have emerged. They include:

(i) the difficulties in identifying the various types of asbestos fibres present in various constructional materials. Although it is true that the various types of asbestos have quite different appearances in the raw state, once they have been incorporated into a product and possibly subjected to changes by the heat, weathering and abrasion, their positive identification is by no means simple. An additional complication is the possibility that different types of asbestos may be found in the same products which may also contain fibres other than asbestos;

(ii) the difficulties which may be encountered in counting very low concentrations of asbestos fibres. At the levels proposed above, there are doubts on the accuracy and sensitivity of the methods used, and quite large uncertainties may exist about the actual concentrations present in existing buildings;

(iii) whether the decision to differentiate between blue asbestos and the other types as far as health risks are concerned is justified. An argument could be advanced that all should be regarded as being of equal concern with respect to the production of some of the asbestos related diseases.

Two important considerations now are: (i) what to use in place of the asbestos-based products which will not be specified in the future; and (ii) if it is considered an acceptable alternative to replacement; what treatment to apply to asbestos products already installed to reduce potential health risks to an acceptable level. Whatever is used must have a similar performance to the asbestos product previously used and because of the wide variety of uses, it seems at the moment unlikely that any single material is likely to have all the attributes of asbestos including its ready availability.

The alternatives could be divided at the moment broadly into two classes:

(i) those based on fibrous materials incorporated into matrices whose compositions would be similar to those used for asbestos products; and (ii) those based to some extent on plastics materials.

Any fibre-based substitute would need to be cleared from a health point of view, since it is possible that some fibres might produce undesirable ill effects similar to those produced by asbestos.

With 'plastic' based materials an important difference in likely performance between asbestos-based products and the substitute could be with respect to fire.

Appendix

The use of the following materials containing asbestos be permitted in any new buildings:

a. asbestos-based insulating boards (for example, 'Asbestolux' and including 'asbestos wood'), when used for *permanent* partitions, wall and ceiling linings and in the construction of one-hour fire-checked doors, which are installed and sealed with an approved decorative finish (see also recommendation 'g');

b. asbestos-based tiles *permanently* fixed to a wall or ceiling by means of adhesive, nailing or screwing and which are sealed with an approved decorative finish (see also recommendation 'e') and vinyl-asbestos floor tiles;

c. asbestos cement products (see also recommendation 'k').

Provided that in all three cases, the specification draws adequate attention to the precautionary advice of the Asbestosis Research Council, to the Requirements of the Asbestos Regulations 1969 and to item 7 of Development and Materials Bulletin No. 83 (2nd Series) dated March 1975.

That the use of the following asbestos-based materials in any new buildings be not permitted:

d. sprayed or loose asbestos used for thermal insulation, acoustic absorption or fire-proofing purposes;

e. asbestos based tiles used for acoustic absorption or for suspended ceilings (see also recommendation 'b');

f. thermal insulation or acoustic absorption material containing asbestos, whether preformed or not, applied to pipes, heating and ventilation ductwork, boilers, etc.;

g. asbestos insulation boards ('Asbestolux' and including 'asbestos wood') for *temporary* partitioning, for example, as a protection to plant during building operations (see also recommendation 'a');

h. asbestos pads, quilts, rope, etc., including bagged asbestos for fire-proofing pipe/conduit holes, except with the written approval of the Technical Supervising Officer;

j. paint containing asbestos;

k. asbestos cement ventilation ducts, except where used only for extract purposes;

l. asbestos-based kitchen worktops where only the top and edges are protected by asbestos-free decorative laminates;

m. foamed asbestos, except with the specific written approval of the Technical Supervising Officer.

In the case of all the above restrictions ('d' to 'm' inclusive), alternative materials or forms of construction are available.

Professor Elmes is Director Designate of the Medical Research Council Pneumoconiosis Unit, Cardiff.

Current Information on the Health Risk of Asbestos

Professor P. C. ELMES

The view expressed in this paper is that of a physician who has been concerned with the investigation and care of patients presenting with asbestos-induced disease and not the official or agreed view of any organisation. My clinical experience has been with cases arising from industry in Belfast and therefore mainly related to shipbuilding. I have supplemented this by collaborative studies on patients from other parts of the British Isles.

Exposure to asbestos can result in five situations:

1. *The presence of asbestos in the* tissues without disease

Examination of the pieces of lung taken from patients at operation or after death often reveals asbestos. The frequency depends on how carefully you look, but relatively simple techniques reveal asbestos in 25-50 per cent of the lungs of all elderly urban dwellers. By itself this simply means that the patient has inhaled asbestos at some time but not that he *necessarily has any asbestos induced* disease.

2. The presence of asbestos in the tissues causing certain benign changes

Warts on the fingers and hands, and pleural plaques which may calcify are often found in people who are working or have worked with asbestos. They are not in themselves important but the pleural plaques may indicate a level of exposure high enough to lead to more serious disease.

3. The presence of asbestos in the tissue and a mesothelioma (cancer) around the lung or around the intestines

These tumours can occur without asbestos exposure. But in areas where there is frequent industrial use of asbestos, especially if this has included crocidolite, these tumours are relatively common and eighty or ninety per cent are associated with some exposure starting many years before the tumour appears. There need not be any other evidence of asbestos tissue damage, but plaques and more severe lung damage may be present.

4. Asbestos in the lungs with tissue damage and primary bronchial cancer

This is a serious risk in people who work regularly with asbestos and smoke. Bronchial cancer is not thought to be common in asbestos workers who do not smoke.

5. Asbestos present with potentially fatal damage to the lungs but no cancer

This is the disease called asbestosis. When exposure is heavy it can be fatal after only 15-20 years, but in these islands it is now rarely severe enough to cause breathlessness before the retiring age or before the patient develops a bronchial cancer.

On the whole there is a dose-related progression from 1. to 5. but there are other factors related to the kind of asbestos, the smoking habits of those who are exposed, and even their own inherited tendency towards other diseases. I will describe some of what we know of these influences.

Physical Factors

a. In the tissues

Asbestos is refractory material and when it gets into the tissues from air breathed into the lungs, through the wall of the gut after being swallowed, or through breaks in the skin, it can survive in the body for many years. Because the tissues of the body are moving all the time the needle-like fibres are pushed around the body. They have been found in small numbers in all parts of the body but have only been demonstrated as causing damage in the lungs, the pleural covering of the lungs, the peritoneum covering the intestines, and the skin.

b. The filter mechanism

People who are exposed to asbestos dust in the air, filter out the larger particles in the nose and throat. Smaller fibres get down into the trachea, bronchi and smaller airways but because of the way the air spins in vortices as it passes down in the lungs, the fibres are thrown outwards and caught on the sticky lining of the airways. From here they are carried back out of the lungs in the mucus by the beating of the cilia. When they *reach the larynx they are swallowed.* The curly fibres of chrysotyle are more likely to be caught and filtered out by this system than the straight fibres of the other forms of asbestos in commercial use. To escape this filter mechanism the fibres must be light enough to remain in suspension and short enough not to get caught across the smaller airways. One would expect this to limit the length to less than 10u in length and perhaps 1/100 *of this in diameter. However, exami*nation of the lungs of exposed humans has revealed straight fibres in the lung up to 200u in length and also bird's nest-like tangles of chrysotile which may be even longer if stretched out. It is relatively easy to imagine how a rigid needle-like fibre caught obliquely across a small airway can get forced through the wall into the tissue by the concertina-like movement of the lungs during breathing. How the bird's nests get down is not so easy to explain. Once a fibre is carried beyond the ciliated part of the airway it may still get deposited and stay or get carried out again with the next outward breath. The proportion which get caught at this stage still depends on size. Most of the longer ones get caught and most of the very small ones are blown out again. But because in the usual dust cloud there are millions of very small fibres compared with only hundreds or thousands of larger ones more very small fibres are retained in the lung than larger ones. Many of these very small fibres are too small to be counted with a light microscope even if they get coated with ferritin and can only be counted by examining the lung or digests of lung under the electron microscope.

I have dealt with this aspect of the problem in some detail because it explains certain anomalies in the evidence which has been used in the discussion of the dangers of different types of asbestos.

Occupational Factors

Dust measurements have been made in certain occupations for many years, but they did not include the sort of detailed analysis of the size and shape of the particles that we now believe to be important. Nevertheless more careful studies made now do permit estimates of the dust cloud characteristics to which workers must have been exposed in the past. Some of the epidemiological findings seem to have been explained but others have not. As I have already indicated the blue asbestos, crocidolite, is more likely to be retained in the lung and remains in the tissues for longer. The material mined in Western Australia is particularly dangerous because it disintegrates readily into finer fibres than that mined elsewhere and is most likely to be retained in the lungs. Miners of asbestos seem to be less at risk than primary process workers who in turn seem less at hazard than those who use processed asbestos under dusty conditions. It is possible that freshly mined asbestos, although it can be inhaled, is still aggregated in bundles and less likely to be retained in the lung or if retained less likely, weight for weight, to be damaging. The more processing the asbestos receives, the finer the division of the fibre bundles and the more dangerous it becomes. There are no detailed dust studies to support this and it has been suggested that other damaging materials may be added to the asbestos during transportation or processing. Chemical analysis has failed to suggest a likely agent. It might simply be that mining is carried out in the rural areas by people with little exposure to other atmospheric pollutants. Primary and secondary industrial use of asbestos is done in highly polluted urban environments by people exposed to many non-respiratory toxic agents as well. Cigarette smoking may be one factor in that smoking is usually not permitted underground in a mine and there may be a synergy between cigarette smoke and asbestos dust only when they are inhaled simultaneously.

The Lung's Response to Retained Dust

1. Asbestosis

Dust landing on the surface beyond the mucociliary mechanism is normally removed by special scavenging cells called macrophages which lie in wait on the walls of the alveoli for this purpose. If the dust particles are small enough they are engulfed by the macrophage with a globule of fluid but remain surrounded by a thinned-out piece of the wall of the cell. Enzymes are added by the cell to the fluid around the dust particle in an attempt to dissolve it rather in the manner that biological detergents are supposed to remove dirt from your clothes. Material that does not dissolve accumulates in the cell until it can take on no more. Then the cell migrates into the lung's drainage system (the lymphatics) to sit for the rest of the individual's life either in a lymph node close to where the main airways enter the lung, or close to the lung surface. Very small particles of asbestos are handled in this way and may be harmless. Longer fibres burst the thin membrane with which the cell attempts to surround it and the enzymes leak out not only killing the macrophages but damaging the cells in the neighbourhood. The longest retained fibres may be engulfed simultaneously by several macrophages all of which may be destroyed. This process may be repeated until the fibres become coated by ferritin or neutralised in some other way. These longer fibres, whether or not they are coated with ferritin to form asbestos bodies, may get carried in the drainage system towards the hilar lymph nodes or to the pleura.

The lung has a very large space capacity for forming the scavenger cells (macrophages) and stowing them away full of small dust particles. Unlike other types of dust exposure this capacity is not approached in asbestos workers. Lung damage results from the killing of macrophages by the longer and very long fibres. It is possible that the very short fibres packed away in macrophages may lead to the formation of the special type of cancer (mesothelioma) but unlikely that they lead to bronchial cancer. When a macrophage is killed as a result of trying to remove an asbestos fibre, chemicals are released from inside the dead cell which cause an inflammation. This is a non-specific reaction which occurs after any tissue injury. Repair processes are stimulated and if the damage is not severe or continuous the tissue of the lung may return to normal. But above a certain level of damage the normal structure of the lung is gradually replaced by scar tissue which prevents normal function. The scarred area of lung ceases to act either as a bellows taking in and blowing out air, or as a place where oxygen replaces the carbon dioxide in the blood. Even the blood vessels cease to carry blood through the damaged area.

Although dust breathed into the lung is distributed to all lobes, it is the lower part of the lung which is used most and which gets damaged first. Over a period of years (10-15 years in the factory situation before 1933, now rarely before exposure of over 40 years) this scarring of the lower part of the lung gradually increases and moves up as the worker has to use the next piece of lung to replace the damaged parts. X-rays show up this damage but the changes are not easily recognised until the worker is already complaining of breathlessness. By this time special breathing tests will also demonstrate a defect in the working of the gas exchange part of the lung. A diagnosis of 'asbestosis' can now be made by examining the patient, by X-ray and by breathing tests.

Examination of the spit for asbestos bodies and biopsy of the lung is not necessary or helpful.

There are two difficulties here:
(i) other diseases. Chronic bronchitis especially in heavy smokers, asthma and a number of other chronic lung disease may so distort the functioning of the lung and the X-ray picture as to make it impossible to detemine the extent or even the presence of asbestosis;
(ii) progress of the disease. In the individual worker it is not possible to diagnose asbestosis at a really early stage. It may be possible to detect early changes in a group of workers and change the working conditions so as to prevent disability. The severity and progress of asbestosis seems to depend on the amount of asbestos retained in the lung, but as indicated earlier we do not know whether the fibres cause damage mainly when they are first inhaled. They may continue to cause damage at a constant rate indefinitely or they may cause a diminishing amount of damage as the years go by. Some progress (and certainly no improvement) occurs after men with asbestosis cease their exposure.

We are still a long way from determining the level of exposure, the duration of exposure and the exact type of fibre which is needed to trigger off this sinister cancer. Cigarette smoking may have nothing to do with it. The process may take anything from 15 to 55 years and in some instances fibres may have been inhaled at only a relatively low concentration for a few weeks to produce a cancer forty years later. On the other hand these cancers are relatively uncommon in people exposed to enough asbestos to cause asbestosis. In Belfast relatively few of the insulation working group have died with a mesothelioma (13 as compared with 35 dying of primary lung cancer). The majority of our mesotheliomas in Belfast (and we have seen over one hundred and fifty) have been in men who have only been exposed to asbestos dust produced by other workers and have not used the material much themselves.

As we cannot define the conditions which cause this cancer it is impossible to set safety limits to prevent it. The evidence in favour of crocidolite, blue asbestos, being the most frequent cause, is sufficient to justify an almost complete ban on the use of this material. The difficulty arises in the accidental exposure to dust from material containing crocidolite made years ago.

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Safety Measures when Handling Asbestos

R. M. WAGG

Asbestos has been known for a long time. There is evidence of its use in the stone age, and it may also have been used by the Egyptians in the preparation of textiles. Its role in technology, as a material of commercial importance, dates from about 1890, when some 1,000 tons were produced. Today the annual world consumption is of the order of five million tons, and it has been estimated that asbestos in one form or other is used in over 3,000 products.

There are six main types of asbestiform minerals, these being derived from two large groups of rock-forming minerals, the serpentines and the amphiboles. The principal asbestos minerals used commercially are fibrous serpentine or chrysotile (white asbestos) and of the amphiboles, amosite, anthophyllite and crocidolite, the latter is commonly known as blue asbestos. The chemical nature and crystalline structure of asbestos are of essential importance for their technical application. Differences in structure of the various fibre types also leads to differences in chemical and physical properties.

In the natural state the asbestos occurs in bundles of fibres and the ability of asbestos fibres to divide longitudinally into finer fibres is one of their most valuable and characteristic properties. Health hazards associated with asbestos are dependent upon the length and diameter of the asbestos fibre, which cannot be attributed in general to asbestos. The diameter of an asbestos fibre is of fundamental importance in determining the falling speed of the particle when released to atmosphere.

Occupational Disease

The first case of asbestosis in England was described in 1906, but it was not until the late 1920s that asbestos was shown to be a major occupational hazard in the textile industry. As a result the Asbestos Industry Regulations of 1931 were made, and came into effect in 1933. These Regulations applied to a number of scheduled processes, and the general effect was to require the use of exhaust ventilation systems in such a way that no asbestos dust could escape. With the improvement of hygienic and technical precautionary measures, and with more widespread and increased use of asbestos elsewhere, asbestosis became more and more frequent in those industries where such technical measures are more or less unfeasible.

Excluded from the regulations were the thermal insulation industry and the application of sprayed asbestos during building construction.

An increased incidence of lung cancer was shown to be associated with exposure to asbestos in a study of scheduled occupations by Richard Doll in 1955. Doll's study had also shown that those exposed only to the improved conditions in the factory had little or no excess risk of bronchial cancer and that the risk of asbestosis had been materially reduced. Further studies in the medical field led to increasing concern over the risks associated with exposure to crocidolite asbestos. Wagner and his colleagues in 1960 reported the first of a group of pleural and peritoneal tumours known as mesothelioma amongst crocidolite miners in the NW Cape Province, South Africa. Similar tumours among crocidolite workers in Britain were also confirmed.

This continually disturbing trend of asbestos-related disease, and the more recent association of mesothelioma with asbestos, led to the introduction of the Asbestos Regulations 1969.

Legislation

Considerable progress toward safe working with asbestos has been achieved by legislative measures and their adoption. The Asbestos Regulations 1969 came into effect in May 1970 and had a much wider sphere of application than previous legislation including areas in which significant quantities of asbestos were used, but which were not covered by the Asbestos Industry Regulations 1931, and having more positive standards of dust control.

The processes may be those occurring in factories, electrical stations, certain institutions, warehouses, ships in course of construction or repair, and building operations or works of engineering construction including demolition processes. For the purpose of the Regulations, asbestos is defined as any of the minerals, crocidolite, amosite, chrysotile and anthophyllite. The Asbestos Regulations 1969 apply to every process involving asbestos or any article composed wholly or partly of asbestos except a process in connection with which asbestos dust cannot be given off. The term 'asbestos dust' is used frequently throughout the Regulations and is defined as dust consisting of or containing asbestos to such an extent as is liable to cause danger to the health of employed persons. The effectiveness of the Asbestos Industry Regulations 1931 was limited in as much as asbestos dust was not defined and was not quantifiable. Standards therefore became dependent on subjective judgment. The Asbestos Regulations 1969 adopted the British Occupational Hygiene Society recommended standard for chrysotile asbestos as the basis of defining in quantifiable terms for exposure to asbestos dust. The administrative interpretation of the term asbestos dust liable to cause danger to the health of employed persons is published in Technical Data Note 13.

One significant feature of the asbestos dust standards is the adoption of an arbitrary standard for crocidolite asbestos of 0.2 fibres/ml of air over a ten minute sampling period. This unvalidated standard recognised the potential carcinogenic nature of crocidolite asbestos, and its adoption has resulted in cessation in usage of crocidolite in manufacturing processes because of the ensuing technical difficulties of complying with the standard.

The legislative effect of the Health and Safety at Work etc. Act 1974 increases even further the spectrum of persons who may be occupationally exposed to asbestos and extends to those who may be exposed, though not occupationally. HM Factory Inspectorate will enforce in situations subject to HSW Act similar standards to those applicable to the Asbestos Regulations 1969.

Prevention of Risks and Exposure to Asbestos

The problem of prevention of harmful dust emission is complicated because of the variety and range of products containing asbestos and its wide and varied use and application. The chemical and thermal resistance properties of asbestos fibres makes them virtually indestructible, thus in many applications the materials will endure to the point when they must eventually be removed and this should be carried out in such a way that, as in the case of manufacture and application, the possibility of harmful dust emission is prevented.

Substitution

Safer substitute materials rendering the same purpose as asbestos are desirable and such substitutes should be used wherever possible. Extensive use is now being made of other materials for the thermal insulation of plant and buildings. Asbestos insulation and particularly crocidolite sprayed insulation has been widely used in the past for the protection of structural steelwork of buildings, condensation control, thermal and sound insulation of buildings. Alternative materials are now being used such as spray insulation containing mineral or ceramic fibre and vermiculite compositions. Man-made mineral fibres are being used to an increasing extent in the production of non-asbestos insulation boards for use in the shipbuilding industry and ceramic fibres as high temperature insulants and also for the manufacture of protective clothing. Nevertheless it is apparent that the properties of asbestos fibre are such that its continued use is unavoidable in a number of materials. Even where alternative materials have been used there will for many years be plant, buildings and ships where the asbestos material formerly used, mainly as thermal insulation, has to be removed. It will be necessary to ensure that such work is performed in such a way that the health of men engaged in such work is not impaired.

Dust Suppression

Wherever technically possible, the process or operation should be designed or redesigned so that dust exposure is reduced to as low a level as possible. For example this can sometimes be accomplished by suppression through wetting or incorporation of the asbestos component into other dust suppressing materials or compounds. Other examples where effective control has been achieved by such methods can be found in certain textile processes whereby the yarn is moistened before spinning or weaving.

There are many operations with asbestos containing materials which are intrinsically dust-free, for example the preparation of rubberised asbestos gaskets is a process which does not produce significant quantities of dust because the bonding effect of the rubber reduces the release of asbestos fibre into the atmosphere. It has been possible to manufacture some asbestos products (e.g. textiles, millboard) in a dust-suppressed form so that they may be used in many applications without producing asbestos dust at concentrations in excess of 2 fibres/ml.

Dust Control

Where it is not possible so to modify a process that asbestos dust is not emitted, the first consideration should be to enclose the process or the dust producing part of the process so that asbestos dust does not escape into the workroom atmosphere.

Total enclosure may not be practicable and in many cases partial enclosure together with exhaust ventilation may be used. Even with a totally enclosed system some exhaust ventilation may be necessary to provide a negative pressure on the system to prevent escape of asbestos dust from joints in the system.

The nature of the process will determine the extent to which the process of operation can be enclosed. Openings in enclosures should be as small as possible, consistent with access to the work. Exhaust draught should be applied to the interior of the enclosure so that air moves inwards through the opening at sufficient speed to ensure that the breathing zone of the operative is free from dust.

When the process cannot be enclosed, hoods forming part of an exhaust ventilation system may be fitted as near as possible to the source of dust. Systems based on 'low-volume high-velocity' principles have proved particularly effective in controlling asbestos dust and swarf emitted from machining operations. It should be emphasised that the design of extraction systems and methods of dust control using local exhaust ventilation for any particular process requires professional expertise and should therefore be referred to a professional ventilation engineer.

Dust Collection Systems

Dust collected by extraction systems must be properly conveyed to dust separation plant. It is important that filtration of the air should be so effective and reliable that harmful emissions of asbestos dust are not transmitted to the general environment or returned to the workroom. Filtration equipment must be regularly inspected and maintained to ensure it continues to operate at its optimum efficiency. Asbestos dust collected at air filtration units should be removed under strictly controlled hygienic conditions and disposed in impermeable containers.

All types of dust control equipment subject to the Asbestos Regulations 1969 are required to be inspected every seven days and thoroughly examined every 14 months by a competent person. The thorough examination requires the system to be checked to ensure that asbestos dust is effectively controlled at each exhaust ventilation hood.

Personal Protection

Where it is impracticable by technical measures to prevent the emission of asbestos dust, personal protection must be provided in the form of respiratory protective equipment and protective clothing. The type of respiratory protective equipment appropriate for different levels of asbestos dust concentrations and different circumstances are specified in Technical Data Note 24 issued by the Health and Safety Executive. At many operations a well fitted approved dust respirator of half mask type will generally be found to be suitable. Where high concentrations of asbestos dust may be encountered or when crocidolite is present more sophisticated respiratory protective equipment is required. This may consist of a high efficiency dust respirator, positive pressure respirator or even air line breathing apparatus.

It is essential that persons who are required to wear protective equipment should be properly trained in its use, and should be fully aware of the reasons why and occasions when the equipment must be worn. Respiratory equipment should be issued to individuals for their personal use and exchanged at suitable regular intervals for cleaning and maintenance by suitably qualified personnel. When not in use equipment must be properly stored to prevent contamination.

Protective clothing should be designed to prevent the deposition of dust on personal clothing and should be manufactured of a material with low dust retention properties. Accommodation should be provided for changing into and out of protective clothing and suitable facilities must be provided to prevent contamination of employees' personal clothing not worn at work. The provision of vacuum cleaning equipment for dedusting overalls before removal at the end of a working period is necessary. On no account should dust be removed by compressed air or brushing. Suitable arrangements must be made for the regular cleaning or laundering of protective clothing.

General Hygiene

When asbestos or asbestos materials are used, particular attention is to be paid to the regular cleaning of premises and plant so that dust is not permitted to accumulate. Where premises have been brought into use since the introduction of the Asbestos Regulations 1969, certain requirements are made for the construction of the building. The purpose of these requirements is to ensure that the building is designed to give the highest standard of general hygiene attainable. There should be the minimum number of ledges on which asbestos dust can be deposited, and provision should be made for the fixed installations of vacuum cleaning plant to maintain the highest standards of plant housekeeping.

Storage and Distribution

Impermeable bags and methods of packaging should be adopted to prevent the emission of asbestos dust during handling and transportation of asbestos and asbestos containing materials. Asbestos waste must be properly sealed during storage and before despatch to minimise environmental contamination during transportation and at the disposal site.

Problem Areas

Demolition

The greatest problem in controlling exposure to asbestos dust occurs during the removal of old insulations, much of which is likely to contain crocidolite. The widely varying methods of work, the itinerant nature of the workforce and often the ignorance and inadequacy of the supervision are factors which contribute to continuing difficulties. The Asbestos Regulations 1969 impose an absolute obligation upon a contractor to notify HM District Inspector of Factories of any process involving crocidolite. To comply with this requirement it is necessary to undertake a thorough survey of the building or plant before work commences and to ensure that an adequate number of samples have been taken to evaluate the risk. The presence of crocidolite or not will determine the standards of respiratory protection required. The removal of insulation material, particularly that containing crocidolite, requires personal protective equipment of a high order as it is impracticable to apply dust control systems which will effectively maintain the levels of airborne dust below the hygiene standards.

The method of work should be an important consideration when dismantling redundant plant or obsolete buildings. The need to remove all asbestos insulation material entirely before commencing the removal or demolition process is imperative. The risks of exposure to asbestos dust, and the difficulty in complying with the Asbestos Regulations are considerably increased unless the asbestos removal is completed first.

To prevent general environmental pollution by asbestos as a consequence of its removal it is frequently necessary to enclose the entire working area by means of polythene screens. Before removal of asbestos insulation it should be thoroughly soaked with water to achieve the maximum dust suppression. The use of probes to penetrate the hard setting finishes is often necessary if effective dust suppression is to be achieved. All waste material must be collected, packaged and disposed of in accordance with Deposit of Poisonous Waste Act 1972.

Adequate facilities should be provided, as near as possible to the working area, to enable contaminated clothing to be vacuum-cleaned before removal of respiratory protective equipment. Accommodation must be provided for storage of protective equipment to prevent contamination of normal clothing. At larger operations the use of portable equipment comprising dirty and clean locker room facilities separated by adequate washing or shower facilities should be provided.

Construction

Asbestos or asbestos-containing materials are frequently used in the construction of many buildings. The use of sprayed asbestos insulation has now been entirely abandoned although much is present in existing buildings. The most common materials used are insulation boards and asbestos cement products. The machining of insulation board and other fire resisting boards containing asbestos will give rise to levels of airborne asbestos dust such as may attract the Asbestos Regulations. Much will depend upon the nature of the work undertaken and the frequency and extent of exposure, use of power tools, such as portable circular saws, jig saws and power drills will give rise to significant quantities of dust and a system of local exhaust ventilation applied at the appropriate tools will be necessary to control the emission of dust. Simple operations on asbestos cement sheet such as drilling, and a limited amount of hand sawing present a negligible risk provided these operations are carried out in the open air.

Asbestos in Buildings

Whilst the majority of persons working with or manipulating asbestos are fully aware of the potential risks many buildings are heavily insulated with sprayed asbestos insulation. The occupants are often unaware of its existence and under normal conditions of use within the building the risk is minimal. However in many cases insulation may be damaged, during structural alteration or during maintenance and repair of other services, often through ignorance. This might lead to unacceptable levels of airborne asbestos dust in a working environment to persons completely unaware of the presence of asbestos. Occupiers and owners of property should be aware of the potential risks and buildings should be surveyed. Simple treatments such as application of sealant is often all that is necessary to prevent fibre release from the sprayed asbestos surfaces. Where there is mechanical damage then other forms of protection will be necessary. Guidance on procedures to be adopted to ensure a safe working environment have been published by the Health and Safety Executive in Technical Data Note 52.

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Heating and Ventilation Aspects of Energy Conservation

R. FULTON CEng MIMechE

The recent evolution of the international energy source market, combined with the exponential growth of consumption, recorded in the world for many decades, makes the problem of energy conservation increasingly important and worthy of the fullest attention.

So far, the overall supply of primary sources has kept up with the demand. However, a picture of plentiful low-cost energy supplies, typical even of the recent past, has given way to a phase of rising costs.

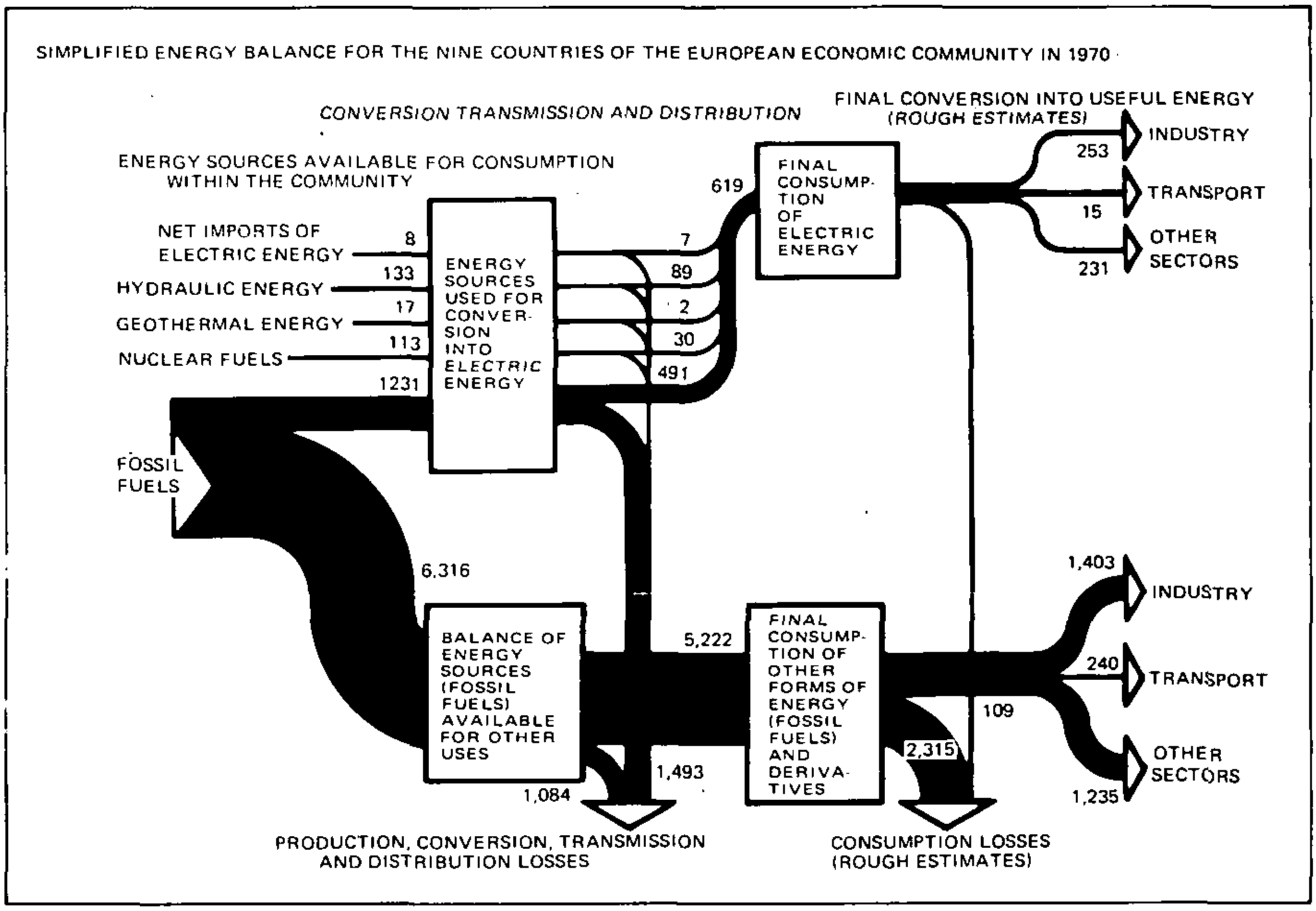
In any event, the stresses on the energy market and the relatively limited reserves of certain primary sources have created serious concern about the future.

The conservation of energy has two facts: the first concerns the more efficient use of energy itself and therefore constitutes a technical economic goal towards which engineers and other experts have always been bending their efforts.

The second concerns the elimination of wastage and the importance that may be attached to the elimination of wastage in the future.

Waste of energy cannot be defined as one particular branch of the use of energy. *Diagram 1* shows a simplified energy balance for the nine EEC countries, and losses or wastages amount to a formidable total, representing as the diagram shows, about 30% of all available energy lost in production, conversion, transmission and distribution. In addition approximately a further 30% is lost at the point of consumption.

DIAGRAM 1



Therefore in the US, which from an energy standpoint could provide a rather significant picture of the conditions which in a few years' time will prevail in many industrialised countries, space heating and air conditioning account for over one-fifth of the total energy consumption. This is a substantial figure on which sizeable savings can be achieved.

SECTOR AND END USE	CONSUMPTION 1960	CONSUMPTION 1968	ANNUAL RATE OF GROWTH	PERCENT OF NATIONAL TOTAL 1960	PERCENT OF NATIONAL TOTAL 1968
RESIDENTIAL					
SPACE HEATING	4,848	6,675	4.1%	11.3%	11.0%
WATER HEATING	1,159	1,736	5.2	2.7	2.9
COOKING	556	637	1.7	1.3	1.1
CLOTHES DRYING	93	208	10.6	0.2	0.3
REFRIGERATION	369	692	8.2	0.9	1.1
AIR CONDITIONING	134	427	15.6	0.3	0.7
OTHER	809	1,241	5.5	1.9	2.1
TOTAL	7,968	11,616	4.8	18.6	19.2
COMMERCIAL					
SPACE HEATING	3,111	4,182	3.8	7.2	6.9
WATER HEATING	544	653	2.3	1.3	1.1
COOKING	98	139	4.5	0.2	0.2
REFRIGERATION	534	670	2.9	1.2	1.1
AIR CONDITIONING	576	1,113	8.6	1.3	1.8
FEEDSTOCK	734	984	3.7	1.7	1.6
OTHER	145	1,025	28.0	0.3	1.7
TOTAL	5,742	8,766	5.4	13.2	14.4
INDUSTRIAL					
PROCESS STEAM	7,646	10,132	3.6	17.8	16.7
ELECTRIC DRIVE	3,170	4,794	5.3	7.4	7.9
ELECTROLYTIC PROCESSES	486	705	4.8	1.1	1.2
DIRECT HEAT	5,550	6,929	2.8	12.9	11.5
FEEDSTOCK	1,370	2,202	6.1	3.2	3.6
OTHER	118	198	6.7	0.3	0.3
TOTAL	18,340	24,960	3.9	42.7	41.2
TRANSPORTATION					
FUEL	10,873	15,038	4.1	25.2	24.9
RAW MATERIALS	141	146	0.4	0.3	0.3
TOTAL	11,014	15,184	4.1	25.5	25.2
NATIONAL TOTAL	43,064	60,526	4.3	100.0%	100.0%

NOTE: ELECTRIC UTILITY CONSUMPTION HAS BEEN ALLOCATED TO EACH END USE.

SOURCE: STANFORD RESEARCH INSTITUTE, USING BUREAU OF MINES AND OTHER SOURCES

DIAGRAM 2 Energy consumption in the United States by end use 1960-1968 (trillions of BTU and per cent per year).

The full picture of the energy usage can be seen from *Diagram 2* which shows that the operation of building services (including space heating, air conditioning, illumination, etc.) accounts for approximately one-third of all fuel consumption in the USA; this is more fuel than is used for transportation and is nearly as much fuel as is used to operate industrial processes.

The use of the term 'energy crisis' to describe present energy problems, has suggested to some that conventional fossil fuels may be in immediate danger of exhaustion. This is not the case. The coal reserves have been estimated to be sufficient to support the present level of coal consumption for 2,000 years or more. The tar sands and oil shale resources of North America are estimated to be sufficient to support present levels of petroleum consumption for approximately one hundred years. However, if present rates of growth of fuel consumption were to be unchecked, a supply of fuel good for one hundred years at today's rates of consumption could be exhausted within twenty to fifty years. Thus, even though the supply of fossil fuels has not yet reached a point of crisis, one can not be complacent about prospects of their ultimate exhaustion. Indeed, it would be possible to exhaust certain of the energy resources within the expected lifetime of many of those present today, should the anticipated growth of energy demand increase as *Diagram 3* indicates.

The air conditioning industry, being primarily responsible for space heating, has therefore a very important role to play in the immediate future.

Effective design in conventional air conditioning equipment can yield substantial improvements in efficiency.

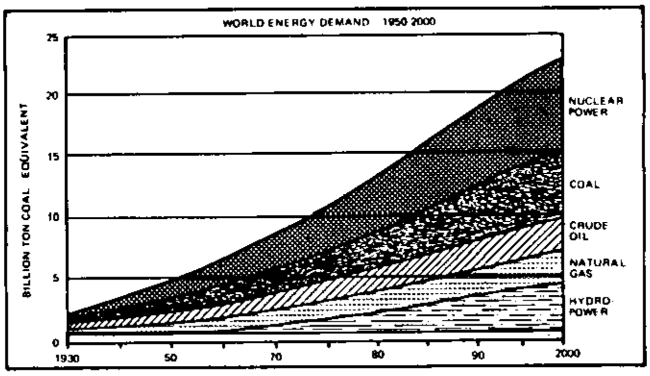


DIAGRAM 3

Reducing the Energy Bill

The quickest way of reducing the energy bill in this industry is by making savings of fuel in our existing buildings. This paper outlines ways in which considerable savings can be achieved in some existing air conditioned office systems without the addition of capital equipment and with only minor changes in controls, together with some relaxations in the internal design conditions.

This paper illustrates how the energy consumption can be systematically reduced by relaxing the winter humidity level, simplifying and yet improving central plant filtration, reducing duct leakage and improving its insulation, and introducing more primary air controls. The example relates to an office building typical of the past 15 years which is air conditioned with a two-pipe varying air temperature system of the fan coil or induction unit type. Energy calculations have been made using one of the Flakt air conditioning energy programmes.

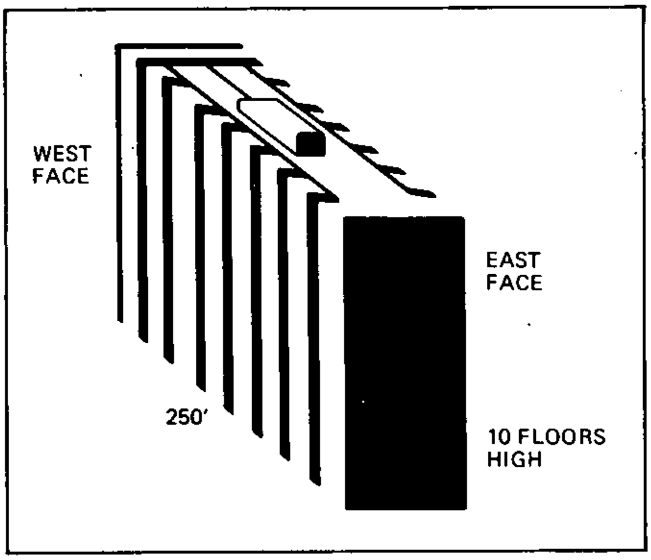


DIAGRAM 4

Diagram 4 indicates the building and lists various assumed values.

Typical air conditioned office, two-pipe varying air temperature system.

Area 100,000ft, 60% double clear glazing, light Venetian blinds, 100ft²/person, 25cfm/person (fresh), wall 'u' value 0.3 Btu/hr/ft²/°F, lighting 4 watts/ft², duct leakage allowance etc. 10%, duct temperature transmission 2.3°F/20°F △ T.

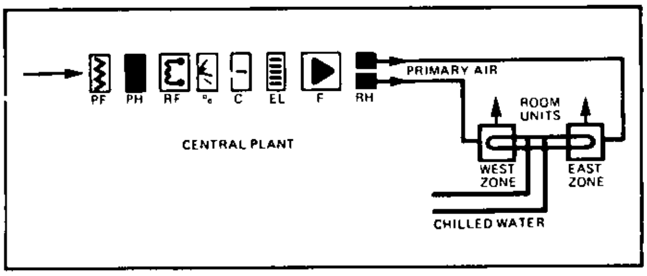


DIAGRAM 5

A typical central plant layout connecting to the two building zones.

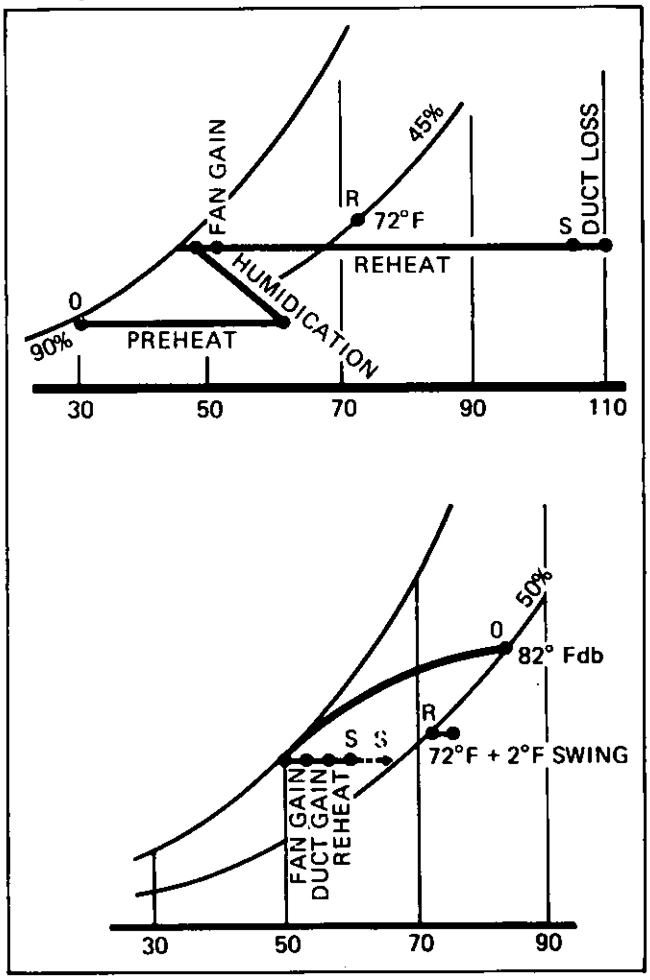
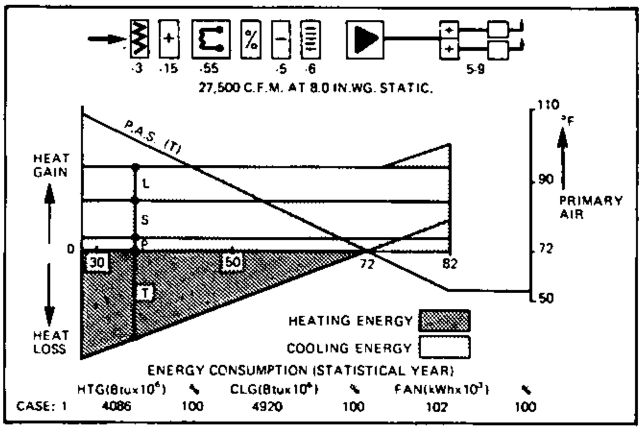


DIAGRAM 6

Diagram 6 shows the winter and summer design psychometric conditions for this plant. O is the outdoor condition, R the room condition and S the primary air supply condition.

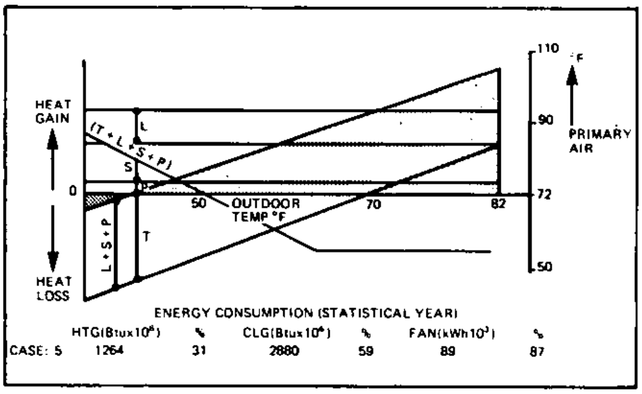
Diagram 7 refers to Case 1. This takes the typical building with the typical system and using the previously listed value and component pressure drops for the dust system quantifies these values and summarises the heating energy, cooling energy and fan energy. The reductions now to be achieved below are measured relative to these values. The graph shows how the primary air schedule (PAS) relates to the heat gains and heat losses plotted against outdoor temperatures. Heat gains shown are lights (l), solar (s), people (p) and transmission and infiltration (t) for outdoor

DIAGRAM 7



CASE: 1 TYPICAL SYSTEM WITH WINTER HUMIDIFICATION
PRIMARY AIR SCHEDULE (PAS)
TRANSMISSION (T)

temperatures above room temperature. The heat loss is for transmission and infiltration when the outdoor temperature is below room temperature. The two shaded areas represent the heating energy and cooling energy.



CASE: 5 WITH PILOT ROOM CONTROL
PAS — T + L + S + P

Diagram 7. Case 5 shows how by replacing both the lights and solar compensation with what is termed 'pilot room control' a further substantial saving can be achieved. This control means that the primary air is regulated by a detector in the room which is in sequence with the room unit/control. This detector controls the zone reheater which cannot apply heat to the zone until the pilot room unit chilled water valve is closed. This prevents the wasteful supply of heating and cooling energy simultaneously. The introduction of this type of energy saving control must necessitate an increase in the tolerances for internal conditions, since identical modules on the same zone will invariably have slightly different heat gains and losses due to varying occupancy etc. The energy summary shows that this method of control makes a considerable saving on the energy used in the more typical system of Case 1.

Diagram 8. Case 6 shows how by paying more attention to the duct system and reducing unnecessary resistances in the index run also by improving the standard of installation and therefore reducing air leakage and by improving the duct insulation, further savings in energy can be achieved. By reducing the duct leakage allowance from

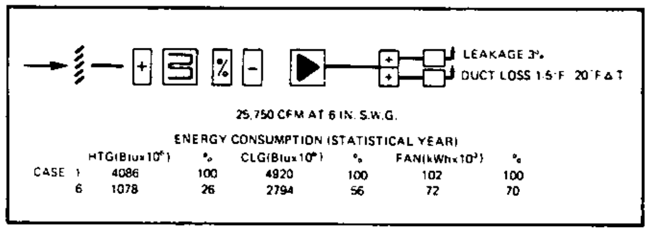


DIAGRAM 8
CASE: 6 AS CASE 5 WITH REDUCED DUCT LEAKAGE AND IMPROVED DUCT INSULATION

10% to 3% it is necessary to condition less air and so save further heating and cooling energy. By supplying less air through the same duct system the overall fan pressure required is also reduced thus saving more fan energy. The energy consumption chart shows how in this example the heating energy required has been reduced to 26% of its initial value, cooling energy consumption to 56% and the fan energy to 70%.

This shortened example shows the relative value of savings that can be made by relaxing some of the comfort parameters, and improving the design and control of a system for a typical office block.

All air conditioning systems in general would not necessarily show the same savings, but it is obvious after having calculated many other installations, including hospitals — by the effective use of computer programmes to simulate and calculate the savings that changes will bring that many systems can show considerable savings in energy consumption for a small cost in time and equipment.

Introducing the Axial Flow Fan as an Aid to Reducing Energy Costs

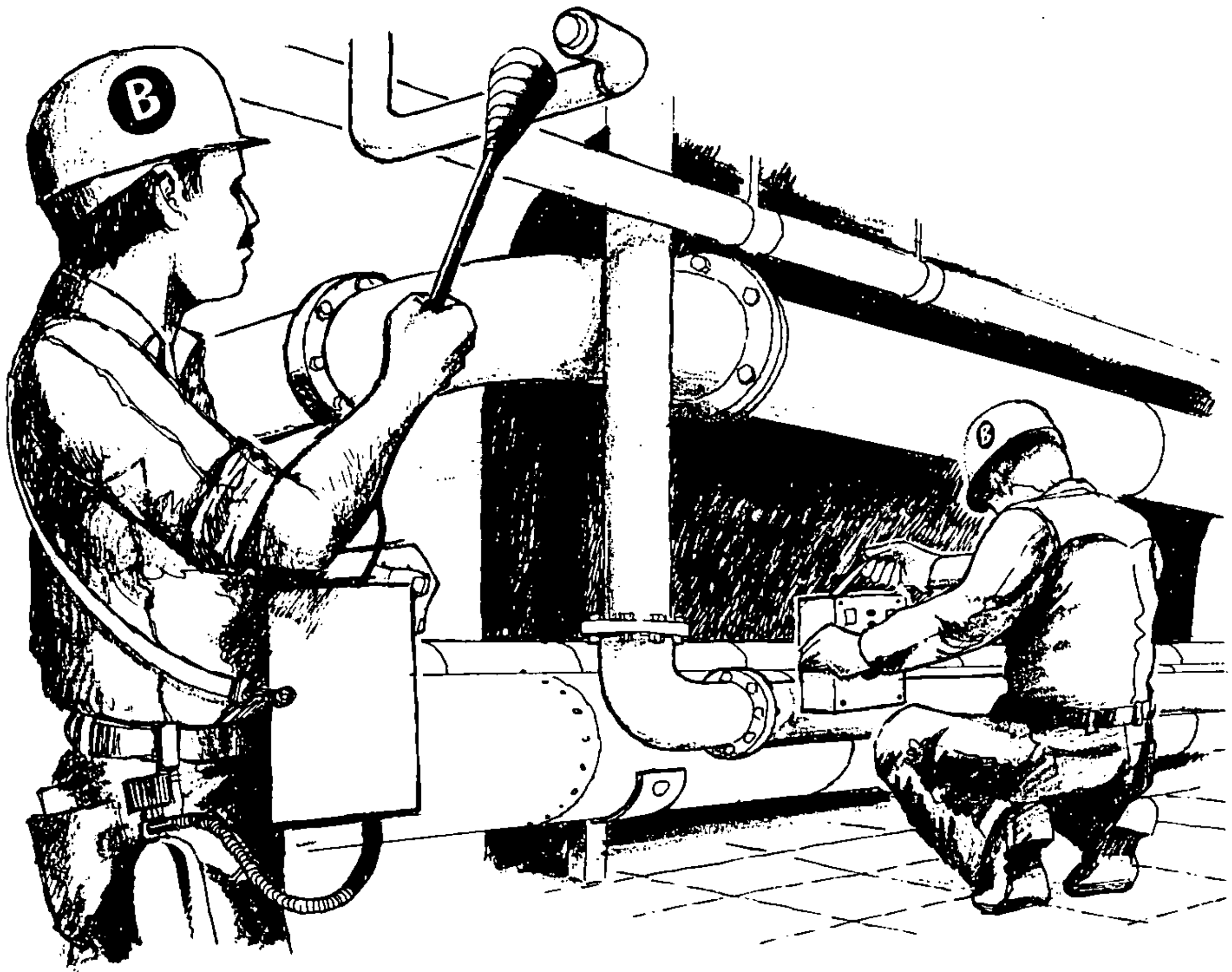
Equipment used in ventilation and air conditioning systems is now more than ever being provided by industry to minimise the energy consumption and therefore the running costs. Among the interesting features has been the introduction of variable-pitch axial flow fans.

There has always been the requirement in air conditioning systems for flow regulation or adjustment. In the past inefficient devices such as dampers have sufficed, with their resulting power wastage.

Today, however, especially in high velocity systems, energy is at a premium. Hence more efficient methods for flow regulation are being actively considered. This paper indicates these alternatives and shows the influence that the VAV concept has had in putting the variable-pitch axial fan at the forefront for air conditioning use.

Most of us are aware of the basic definition of energy which is the capacity of a body to do work. In fan engineering it is the ability of the fan to do work on the air which dictates the efficiency of the unit and thus the unnecessary energy wastage. All fans reputed to be of high efficiency design will be seen generally to consist of some means of energy conversion downstream of the impeller. It is also usual for the impeller to be the prime pressure generator with the scroll or downstream guide vanes contributing to a less but still worthwhile extent.

To illustrate this let us consider the forward curved bladed centrifugal impeller which acts mainly as a momentum gaining device and relies heavily on the scroll for efficient conversion of the resulting high kinetic energy into useful pressure energy. However the resulting overall



efficiencies of the order of 65-68% do little to promote its use in these energy conscious days. In the case of backward curved bladed centrifugal fans most of the useful work occurs within the impeller blades themselves and the scroll acts basically as a collector. These fan units have resulting peak efficiencies of the order 90% and hence have been widely used up to now with inlet vane control for variable air volume applications.

If we now consider axial fans, then for high efficiency it is usual to have either upstream or downstream guide vanes. The latter means is usually preferred from noise consideration and the vanes convert the high swirl velocities into useful pressure energy.

The regulation losses vary with various methods of regulation and *Diagram 9* shows the power consumption rises with fluctuations in air flow, taking regulation losses into consideration. Illustrated are typical variations for a simple damper regulator placed in adjacent ductwork — which is seen to be the least efficient. Guide-vane control — which is at present widely used from initial cost considerations, and the two-speed motor (100/60%) with guide vane control. This latter alternative although better than the single speed approach still suffers from the bad regulation characteristic down to 80% flow rate.

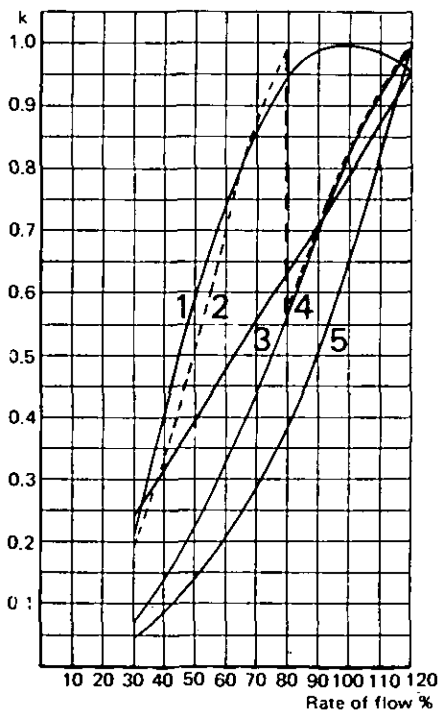


DIAGRAM 9
Increase in power consumption as a function of rate of flow, with allowance for regulation losses.

1, Axico Axial Flow Fan; 2, Two-speed motor, 100/66%, with Guide Vane Regulation; 3, Speed Regulation with Hydraulic Coupling; 4, Guide Vane Regulation; 5, Damper Regulation.

The most efficient contour shown is that of the variable pitch axial which is seen to have a very high K value over most of the flow range.

We will briefly look now at a typical centrifugal fan characteristic (*Diagram 10*) on which are indicated the system lines. These lines are drawn proportional to the spaced square of the air flow, with line 10 being equivalent to the outlet velocity pressure of the unit.

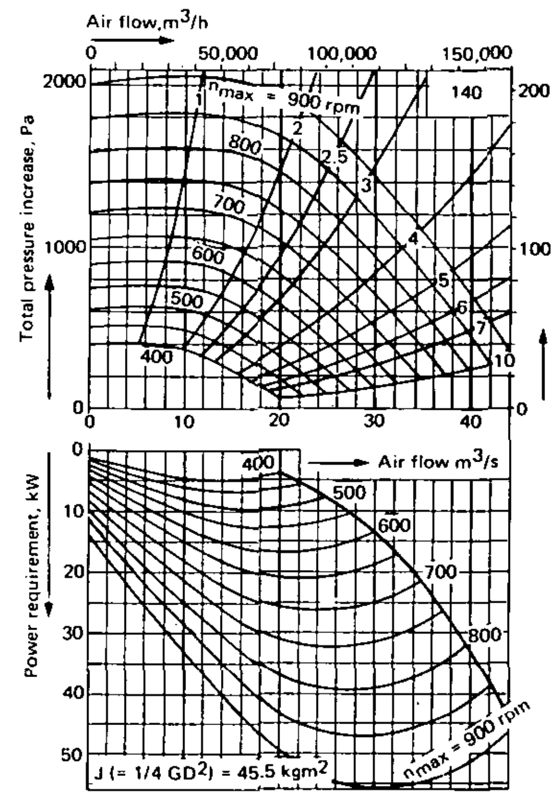
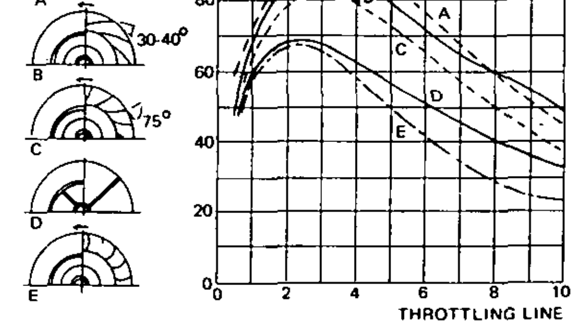


DIAGRAM 10
Performance curves showing throttling lines.

DIAGRAM 11
Overall efficiency for various types of centrifugal fans. Blades for centrifugal fans: A, Backward-curved profiled; B, Backward-curved with 30 to 40 deg. tip angle; C, Backward-curved with 75 deg. tip angle (self-cleaning); D, Straight radial; E, Forward-curved.



We can now compare an efficient backward inclined centrifugal with inlet guide vanes control and a variable pitch axial for the same duty. The centrifugal would normally be selected such that its operating point is close to throttling line 3 (*Diagram 11*), while the axial is at relatively high blade angle as shown in *Diagram 12* such that when operating the working point moves through the highest efficiency region during blade adjustment.

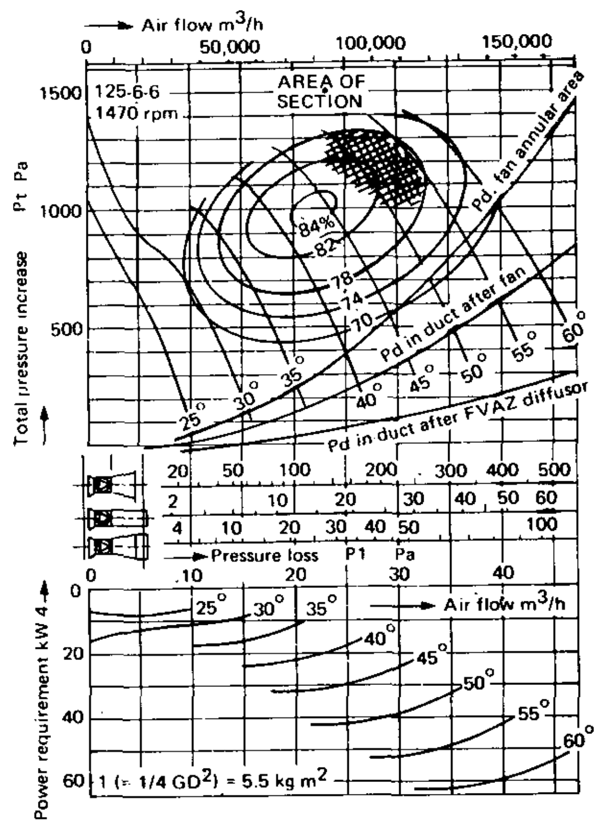


DIAGRAM 12
Typical V-P Axial Fan efficiency contours.

Consider the Example

Knowing that the peak efficiency of a variable pitch fan can be equal to that of the centrifugal being considered and that with direct driven fan units the variation of motor efficiency with load is small, we can approximate the input power relationship to

$$\text{Input power} = \frac{1}{K}$$

based on this and the regulation contours shown we can compare the power consumption at full and partial air loads. We will also include the case of the centrifugal fan with a plain damper which has been seen to be the least efficient of those being considered here.

From the figures in the upper part of *Diagram 13* we can in conjunction with an assumed typical annual fan operating distribution begin to make an assessment of the power and thus energy saving that results in using the VP Axial.

Air flow%	Pressure %	Units of Power consumed (1/K) V.P. Axial	Cent + i.g.v.	Cent + Dampner
110	100	1.02(100)	1.07(105)	1.22(120)
100	83	1.0 (100)	1.25(125)	1.54(154)
70	41	1.18(100)	2.22(188)	3.45(293)
40	13	2.5 (100)	6.67(267)	11.1(442)

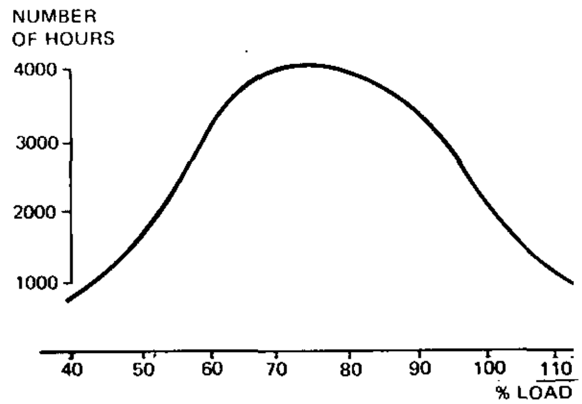


DIAGRAM 13
Typical annual fan operating distribution for VAV system.

Air Flow %	Operating hours per year	Unit of power consumed (1/K) hours		
		V.P.Axial	Cent + I.G.V.	Cent + Damper
110	1000	1000	1050	1200
100	2200	2200	2750	3388
70	4000	4000	7520	11720
40	800	800	2136	3536
	TOTAL	8000	13,456	19,844
Hence typical Resultant Power Percentages		100	168	248

Comparing these resultant power factors gives a clear indication as to the axial fan's supremacy in systems requiring infinitely variable air flows.

The Axico range of variable pitch fans has pneumatic or mechanical control mechanisms of the infinitely variable impeller, together with the sound overall engineering concept of this range, is based on over 15 years of satisfactory operation of the PF range of variable pitch fans in industrial applications throughout the world. The PF series is standardised in 48 sizes which cover the flow range from 10-300 m^3/sec and capable of pressures up to 10,000 Pa. The experiences obtained from this fan were used for the development of the newer axial flow fan for lower pressures, the Axico.

This fan is produced as a complete unit consisting of a casing with a bell-mouth inlet, an impeller with a control mechanism for blade angle adjustment, guide vanes, motor and a motor support framework (*Diagram 14*). This framework is attached to a base grillage which is isolated from

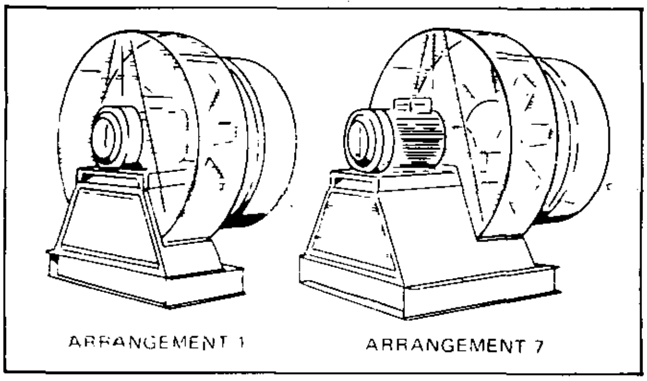


DIAGRAM 14.
Direct-driven Axico arrangements.

the ground by anti-vibration mounts and has attached adequate safety guards. The impeller can be either mounted directly onto the drive shaft (*Arrangement 1*) or mounted on a separate shaft supported on twin bearings and driven through a flexible coupling from a separately mounted in-line motor (*Arrangement 7*). In these arrangements pressures up to 1,800 Pa are obtainable. The fan can also be supplied in a belt-driven version (*Arrangement 3*) capable of attaining pressures up to 3,000 Pa as shown in *Figure 8*.

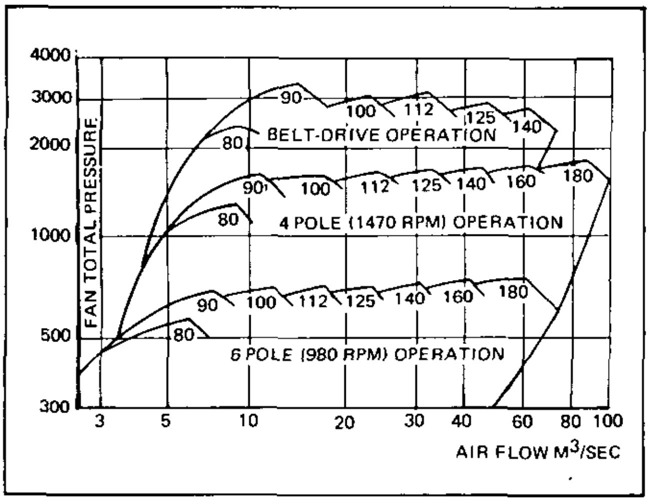


DIAGRAM 15
Axico performance envelopes.

Features of the Axico Fan are:

1. The accurate and positive variation of blade angle using a mechanical feed-back linkage to a positioner, is a standard feature on fans with pneumatic control of blade angle. With mechanical control of blade angle the feed back for positive positioning is incorporated in the actuator itself.
2. The unit has been designed to incorporate the use of standard metric foot mounted motors. There is the option of an arrangement for direct driven operation, which facilitates the complete removal of the motor in the event of a malfunction, without disturbance to the impeller/control mechanism.
3. The provision of a downstream diffuser section incorporating a centre body for the efficient regain of the high annular velocity pressures into useful static pressures. This option of a standard diffuser enables users to obtain a more efficient balance between electrical input power to useful air performance output.
4. The full and thorough illustration of air and acoustic performance information, clearly indicating the variation with different types of installations, namely diffuser termination, duct connection, a diffuser/duct combination or with the fan discharging its flow straight to atmosphere.

Noise Levels

We do not operate Axico units at two pole speeds for obvious noise considerations. By operating at four pole speeds the resultant noise levels are lower, and have a spectrum contour which can be efficiently reduced by normal attenuation. The overall level of the Axico is generally lower or equal to that of a centrifugal for a similar duty.

Fans in Parallel

The operation of two or more fans connection in parallel increases the risk of fan operation outside of its permissible range, especially if the control mechanism allows deviations in the flow between the fans. This risk is eliminated with Axico fans if they are used together with our recommended control equipment. One operating condition which must be avoided is where fans are started

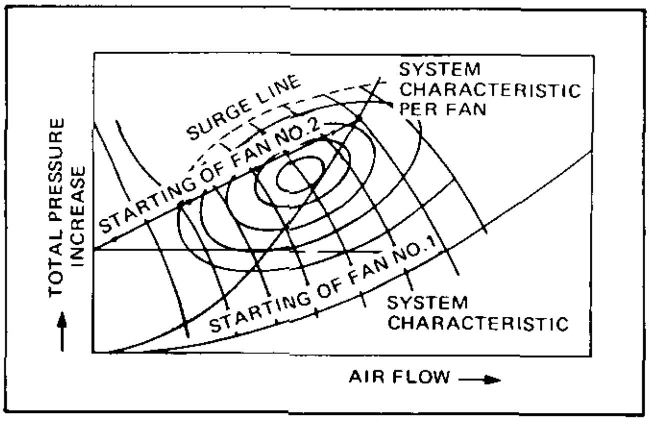


DIAGRAM 16
Operation of fans in parallel.

and take up load one at a time, so that the last fan to start is forced to exceed the surge line. The example shown in *Diagram 16* presents clearly the operating trends for two fans operating in parallel. Fan No. 2 comes very close to the surge line but does not exceed it. If both fans had been controlled in parallel from low load, they would have followed the installation characteristics for each fan, and a considerably better margin against disturbances would thus be available.

The Positioner – its Importance and Function

The positioner is an automatic facility built into the control line/linkage which ensures accurate and reliable blade incidence and hence flow conditions.

On the mechanically controlled fan unit the control actuator is positioned external to the fan casing and applies the required load to the hub by means of the linkage arm. The system control signal which can be either electrical (4-20 mA) or pneumatic (3-15 psi) is sensed by the actuator and converted into a linear stroke.

If this resultant stroke is monitored by a positioner then 'desired' and 'actual' stroke can be compared and any error corrected.

On pneumatically controlled fan units, where the actuators are built-in into the hubs then no external device is required. Unfortunately these built-in actuators have a very large hysteresis which leads to great inaccuracies in the control. Almost all manufacturers have overlooked this with the result that clients have got plants which will not function satisfactorily. From our variable pitch knowledge on the PF fan range we decided without hesitation on a built-in positioner for Axico. By means of this positioner, which mechanically gives the position of the blades — the influence of the hysteresis has been completely eliminated. Together with the control signal the information from the positioner controls the working pressure to Axico's diaphragm.

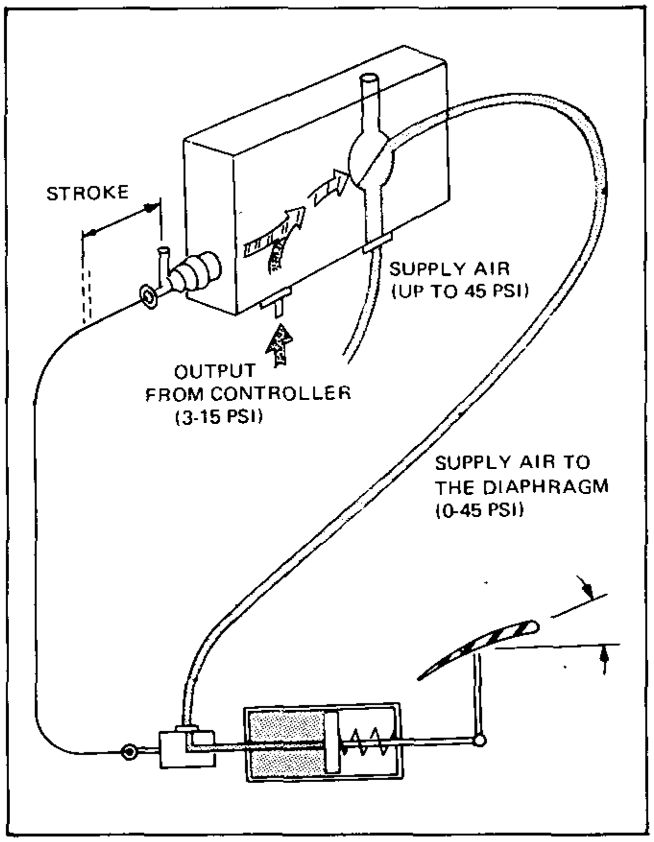


DIAGRAM 17
Positioner network.

A Close Look at the Problems of Hysteresis

If the blade setting angle is drawn as a function of the necessary pressure for the change of the blade angle, a diagram according to *Diagram 18* is obtained. However, due to the large built-in friction within the hub, the resultant blade angle is dependent on whether the pressure at the time is increasing or decreasing. To have two possible blade angles for one input signal is far from ideal.

If instead the blade angle is drawn as a function of the position of the blade, a hysteresis-free curve is obtained. By letting the position of the diaphragm/piston have a proportional relationship to the control signal the same blade angle is always obtained for the same control signal.

Hence an accurate and reliable control method exists.

Even after all available steps have been taken to minimise the energy consumption of a system, waste still occurs because during periods of heating we eject heat from the buildings or processes at a higher temperature than the outside air temperature, but methods of heat recovery are now available.

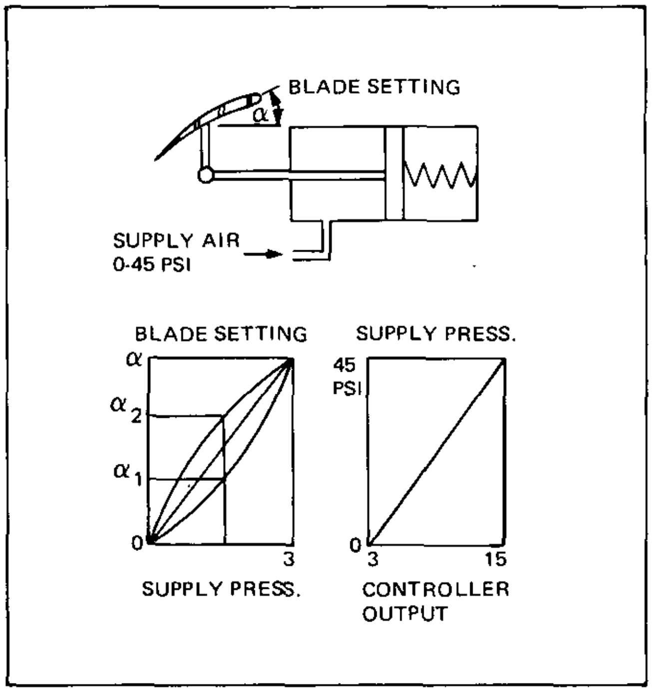
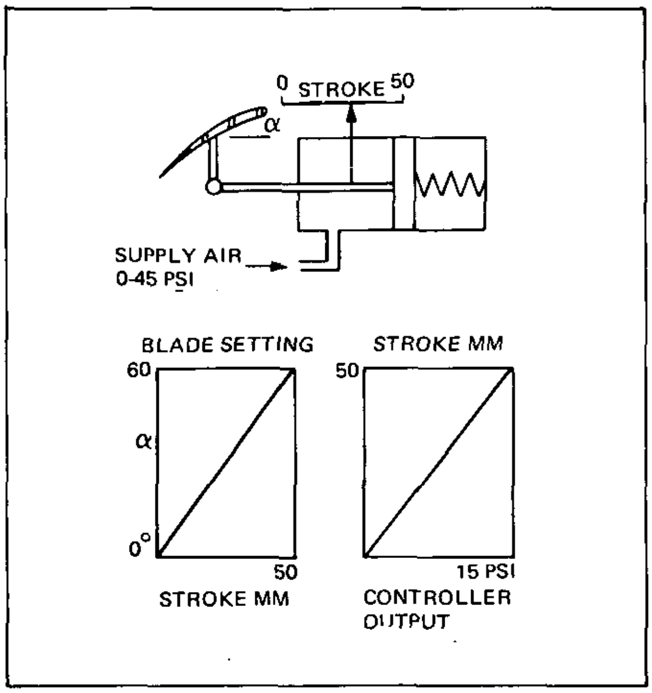


DIAGRAM 18
Hysteresis in pneumatically controlled fans.



Among them being rotating heat exchangers (*Diagram 19*), reverse cycle refrigeration, commonly called heat pumps (*Diagram 20 and 21*), and heat pipes (*Diagram 22*). Another arrangement is the run-around system, as it is commonly known, and is the type discussed in this paper.

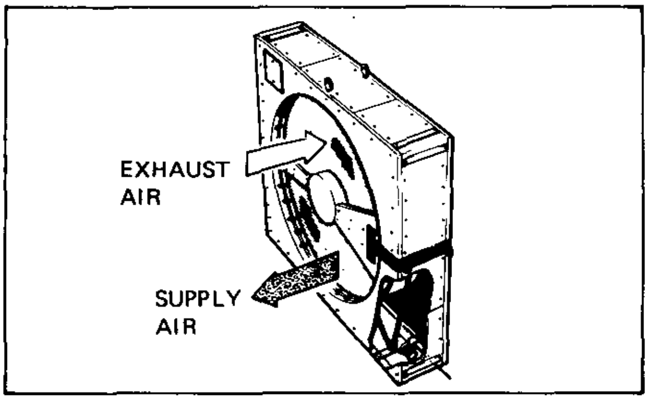


DIAGRAM 19

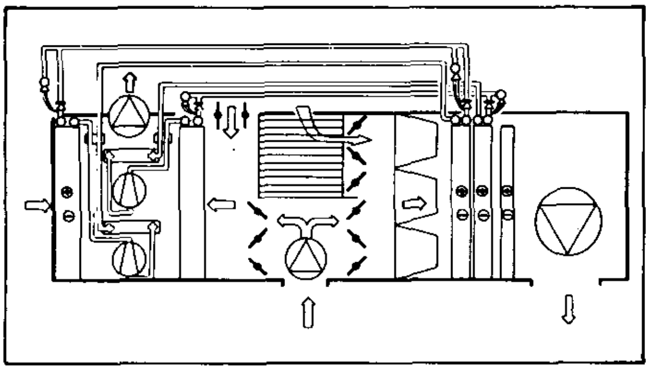


DIAGRAM 20

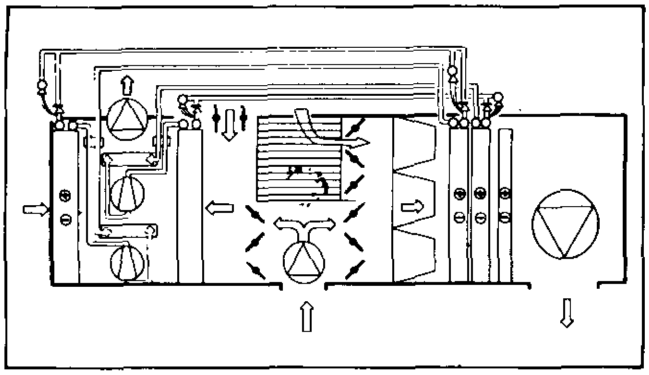


DIAGRAM 21

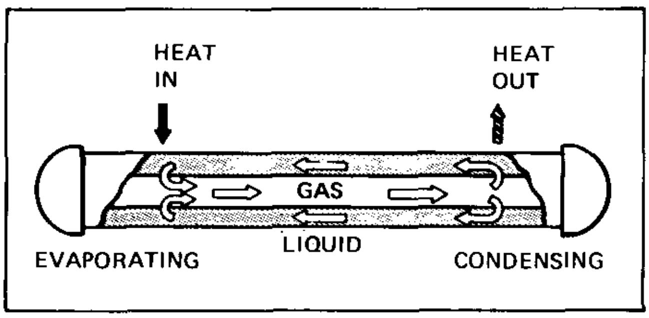


DIAGRAM 22

The Ecoterm System

The Flakt run-around system for reducing the wastage of heat energy is called Ecoterm, and is an indirect stystem, operating with an intermediate heat exchange medium such as a mixture of water and glycol.

The principle of such indirect heat exchange is illustrated in *Diagram 23.* The three most important components of such an arrangement, i.e. the cooling coil, heating coil and pump, are all of standard design and are thus well-proven. As compared to direct and rotating heat exchangers, the advantages offered by liquid-coupled indirect heat exchangers include the following:

no restrictions are made on the locations of the supply and exhaust air ducts in relation to each other;
no risk of leakage between the ducts, i.e. no risk of the transfer of odours and bacteria;
no restrictions in the numbers of supply and exhaust air ducts;
the heat exchangers can readily be incorporated into the ducting;
the finned coil on the air supply side can be employed for cooling during the summer.

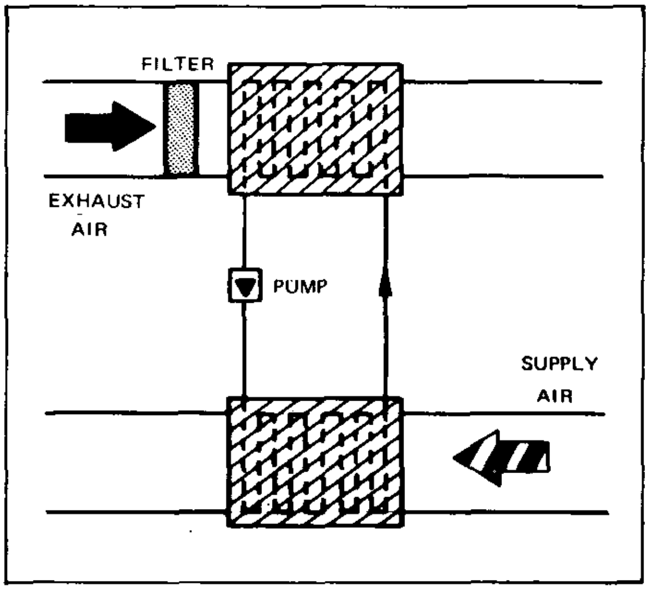


DIAGRAM 23

Other advantages of liquid-coupled heat exchangers are that they are incombustible, and that they are easy to clean by flushing with water. In industrial installations, a further advantage is that heat recovery from the air exhausted from the premises and the process air can easily be combined without complicated runs of ducting. Moreover, very high moisture contents in the exhaust air are permissible, and this is an important consideration in certain industrial premises.

Some of the specially favourable fields of application for indirect heat exchangers are as follows:
industrial premises;
residential premises;
hospitals.

However, indirect heat exchangers may well provide the best economic solution also in other types of premises. This is due to the fact that the installation cost is comparatively low, and this compensates for the modest temperature efficiency. It should be noted that the percentage energy saving is appreciably higher than the temperature efficiency.

A recent installation carried out in Sweden was for five identical systems in a sausage skin factory. The total cost of £70,000 for this system is recovered in less than one year.

Installation Example

Diagram 24 shows an example of the installation of indirect liquid-coupled heat exchangers. One of the heat recovery coils is located in the air supply unit before the heating coil, whereas the other is located in the exhaust air duct. For intermediate seasons three-way valves in the pipe system allow control of the recovered heat energy.

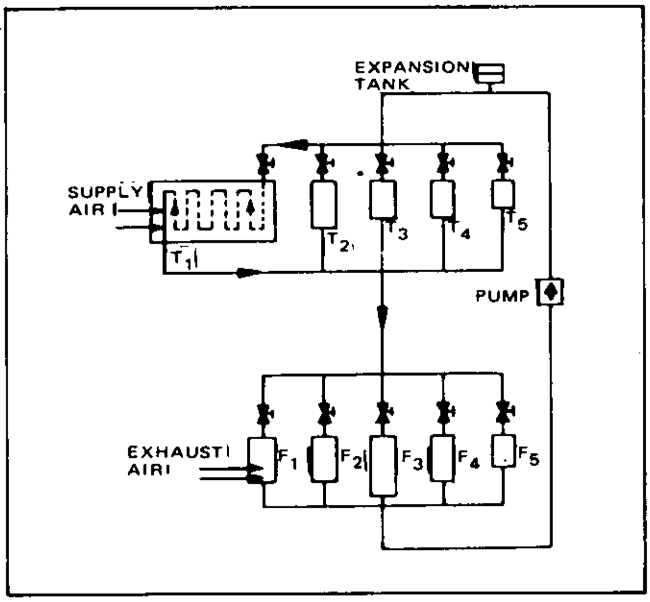


DIAGRAM 24

Solving such complicated equations for eaoh of the temperatures in normal operation would be very time consuming to do manually.

For this reason a computer programme has been developed for sizing of liquid-coupled heat recovery systems in which optimisation rules are utilised. This programme can be used for carrying out the necessary calculations for systems with up to five supply and five exhaust air coils of different sizes, interconnected on the water side (*Diagram 24*). The calculations can be carried out for standard coils used in the Ecoterm heat recovery system from Flakt, and only a few particulars of these coils need to be entered on the input data form.

The required input data include the air flows of the various supply and exhaust air coils, inlet air temperature, and the inlet relative humidity or the enthalpy for the exhaust air streams. If the coil size is not specified on the input data form, the programme will select a suitable size, taking into account the maximum permissible.

An example of the data output form is shown in *Diagram 25* for a calculation of a system with one coil in the supply and exhaust air ducts, respectively. The results include heating capacity, air and water velocity, air and water pressure drop, leaving temperature of the supply and exhaust air and the relative humidity of leaving exhaust air. With the supply air leaving temperature and the inlet temperatures the system efficiency can easily be calculated.

Economical Assessment

Sizing of heat recovery systems is not only a technical question, but also an economic one, and since the economics of heat recovery are dependent on several factors, such as the utilisation of the ventilation system and its design, the method of heating the building etc., an economic assessment must generally be carried out for each individual case. General assessments of the economics are also rendered difficult by the wide variations in the financing rules employed.

An example of the calculation of the economic return for an installed liquid-coupled heat recovery system is given below. To find out the most economical alternative in a practical case, several such calculations may be needed. However, methods for direct determination of the most economical efficiency of a heat recovery system are now available.

RESULT:

ALT. 1

COILS FOR SUPPLY AIR.

NO. OF TUBE ROWS = 8.	HEATING CAPACITY KW	AIR VELOCITY M/SEC	LEAVING AIR TEMP DEG.C	LEAVING REL. HUM PER CENT	WATER FLOW L/SEC	WATER VELOCITY M/SEC	ENTERING WAT.TEMP DEG.C	LEAVING WAT.TEMP DEG.C	PR.DROP AIR PA	PR. WA K
COIL.NR: 1.	P	VO	TU	FIU	QR	VR	TRI	TRU	DP	D
COIL XXXX	157.2	2.7	3.3	---	6.07	1.26	7.1	.3	173.6	29

COILS FOR EXHAUST AIR

NO. OF TUBE ROWS = 8										
COIL.NR: 1.	P	VO	TU	FIU	QR	VP	TRI	TRU	DP	D
COIL YYYY	157.4	2.9	5.2	100.	6.07	1.26	.3	7.1	192.6	29

HEATING CAPACITY, TOTAL..... = 157.2 KW
WATER FLOW.................. = 6.07 L/SEC
PRESS. DROP, WATER SIDE, TOTAL. = 59.10 KPA

DIAGRAM 25

The most time-consuming part of a profitability calculation is the determination of the reduced fuel consumption. By using enthalpy or temperature duration graphs, the annual energy savings for different system efficiencies can fairly rapidly be determined. If the computer programme previously mentioned is used, the heat demand (given as the number of degree-hours) with and without the heat recovery system is directly obtained.

The example presented here applied to a hospital located in the London area. It is further assumed that heating is provided by an oil-fired boiler in the plant. In addition, the calculation of the heating costs is based on an oil price of £36.7/m³ (August 1974), which corresponds to approximately 0.46 p/kWh. When calculating the energy costs, it is assumed that the energy supplied to the pump (usually of the order of 1% of the recovered energy) and to the supply air fan is considered as additional heat during the heating season, and for the fan, as an energy loss during the rest of the year. The calculation of the capital costs is based on an annuity factor of 0.163 (ten years at a rate of interest of 10%) for the heat exchangers and boiler house, and an annuity factor of 0.08 for the buildings.

For the ventilation installation the following particulars are assumed to apply:
Supply air flow = exhaust air flow = 11 m^3/s
Temperature of the exhaust air = 22°C
Relative humidity of the exhaust air = 55%
Supply air temperature after the central unit = 18°C
Operating time = 8,760 h/year.

The investment and operating costs for installing the heat recovery system are summarised in *Diagram 26*. According to the results given in this table a net saving of £2,621 is obtained for an increased investment of £3,350, which means that the payback period (increased investment/net saving) is 1.28 years. If similar calculations are carried out for systems with six and ten row coils of type VBDF one finds according to *Diagram 27* that the payback periods are 1.41 and 1.54 years, respectively. Accordingly, eight row coils seem to be the optimum size in this case.

Instead of increasing the coil depths, the heat transfer area can be increased by increasing the front area of the coils, if practical considerations permit this. A special finned coil with six rows in depth, Flakt-type ORAB, was therefore developed. This coil gives a comparatively high system efficiency at the recommended air velocities 2-3 m/s. As the pressure drop is low on the air side, a considerable saving of electrical energy is obtained where six row coils of this type are used instead of conventional coils with eight or more rows in depth.

When summarising the profitability calculations presented above, it is clear that the installation of energy reducing systems is a good economic proposition and we believe these examples show that energy economy should be practised on all possible existing or new air handling installations.

INVESTMENTS	INSTALLATION COSTS FOR THE RECOVERY SYSTEM (COILS, PUMP, PIPEWORK, FILTER)	£ 4180
	COSTS OF INCREASED BUILDING VOLUME (£25/m³)	£ 1000
	REDUCTION IN INVESTMENT FOR THE BOILER PLANT	£ 1830
	INCREASE IN INVESTMENT	£ 3350
CAPITAL AND OPERATING COSTS	CAPITAL COSTS FOR THE INCREASED INVESTMENT	£ 464/year
	ENERGY AND POWER COSTS (PUMP AND FANS)	£ 271/year
	SERVICE AND MAINTENANCE	£ 100/year
	REDUCED FUEL COSTS	£ 3456/year
	NET SAVING	£ 2621/year

DIAGRAM 26

NUMBER OF ROWS	SYSTEM EFFICIENCY(%)	INCREASE IN INVESTMENT (£)	NET SAVING (£)	PAYBACK PERIOD (YEARS)
6	47	2910	2064	1.41
8	60	3350	2621	1.28
10	65	4150	2702	1.54

DIAGRAM 27

If coils of the Flakt type VBDF with eight rows in depth are used, the computer calculations show that the reduced heat demand amounts to 57,050 degree-hours which at the appropriate air flow and oil price, represents a reduction of the fuel cost of £3,456/year. When the heat recovery system is installed the boiler output can be reduced by 183 KW. Depending on the size of the boiler installation the resulting reduction in investment costs varies substantially from case to case. In the installation being considered, the reduction in investment costs is assumed to amount to £10/KW, i.e. a total of £1,830.

References

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Energy Reductions in Existing Air Conditioning Systems. M. J. Arnold (SF Air Treatment Limited).
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Ecoterm — A Method of Waste Heat Recovery. R. Fulton (SF Air Treatment Limited).

Product News

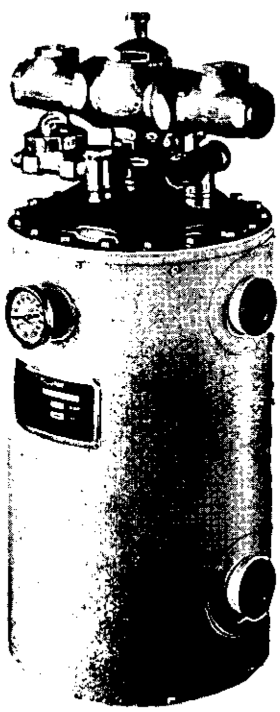
New High Pressure Horne Tepidstat

The Tepidstat, a completely new approach to thermostatic mixing of hot and cold water, was developed during 1975 at the request of two hospital authorities — the Sheffield Regional Hospital Board (now Trent Regional Health Authority), and the Western Regional Hospital Board, Glasgow.

The requirement was for a means of controlling water temperatures more accurately than was currently practicable, this without high capital expenditure. Safety was one of the main concerns, particularly in pediatric, geriatric and psychiatric wards, where scalding could occur if water was available too hot.

Before the introduction of the Tepidstat, accepted practice, where multi-outlets of mixed nature were to be controlled, included fitting individual thermostatic mixing valves at each wash basin, bath and shower point. However, in a hospital having wards with say thirty outlets this could cost £2,000 or more. Low temperature domestic warm water calorifiers have frequently been employed — again the cost was prohibitive and a great deal of space was taken up. A single large thermostatic mixing valve, such as the Horne Hot Water Blender, has been successfully used for many multiple outlet systems, but a high degree of control cannot be guaranteed. Large individual valves allow temperature in the system to rise during periods of no demand if the calorifiers or combination boilers supplying hot water to the valve are also serving other points. In certain circumstances extreme fluctuations can occur.

Horne's New Tepidstat.



The Tepidstat overcomes this problem, temperatures remaining steady whether there is a demand for water or not.

Development work on the Horne Tepidstat was carried out in the company's own laboratories, also at Dumbarton Hospital, where a prototype was installed in June, 1974 — this has been in continuous use ever since.

Basically the Tepidstat comprises a hot water blender, heating coil, thermostatic non-return and safety valves, combined as a single unit. The blender precisely controls the temperature when lavatory basin, showers, or bath taps are running. This it does accurately when all or only a single outlet is being used. The heating coil comes into service making up losses in the pipework during periods of no demand, ensuring water at the correct temperature is always available, but minimising both water and fuel wastage.

The new Horne Tepidstat now introduced, is capable of operating directly off the water mains up to ten bar pressure — this is the current procedure in many countries outside of the UK, and it is possible that we shall adopt this practice to bring us in line with other Common Market countries.

At a cost of less than £500 the Tepidstat show enormous savings over any other method of controlling water temperatures to multi-outlets.

Further information from: *The Horne Engineering Co. Ltd., PO Box 7, Rankine Street, Johnstone, Scotland PA5 8 BD. Tel. Johnstone (0505) 21455.*

New Tabletop Steriliser

Dent & Hellyer Limited of Andover, well-known manufacturers of sterile control equipment, will be exhibiting a new tabletop steriliser as well as a range of autoclaves suitable for use in laboratories and hospitals at Labex International '77, Hall 5, Stand 5332, NEC, Birmingham, March 7-11, 1977.

The new Dent & Hellyer Handyclave export model tabletop steriliser will be one of several units on the stand. The Handyclave is suitable for the sterilisation of small instruments, syringes, metal catheters, etc. A UK version of this unit meeting relevant British standards will be introduced on to the market later in 1977.

Also on show will be the new configuration Slidelock Mark IV media/glassware steriliser with controls housed in a side console, a horizontal chamber laboratory autoclave, a vertical autoclave with swing-aside lid and fully illustrated details of all other Dent & Hellyer equipment.

Dent & Hellyer consultants, able to give planning assistance on equipment packages particularly applicable to laboratory installations overseas, will be available on the stand to discuss any problem relating to the application of sterile control technology in the laboratory.

A selection of Dent & Hellyer equipment is also on display at the British Hospital Equipment Display Centre, 22 Newman Street, London W1P 3HP.

Further information from: *Dent & Hellyer, Walworth Road, Andover SP10 5AA. Tel. 0264 62111.*

Hospital Chute Systems

A £100,000 export order for fireproof linen and waste disposal chute systems for Saudi Arabia is announced by Percy Lane Group Limited, the Tamworth-based manufacturers of glazed aluminium windows for the transport and construction industries.

Won by the Group's Luton-based subsidiary, Hardall Limited, from West German contractor, Polensky & Züllner of Dortmund, the order is for chute systems for the Faculty of Medicine, University of Riyadh, being built to the design of a British architectural consortium.

Featuring Hardall stainless steel rotary drums and fire cut-off doors, the three phase contract is scheduled for completion by the end of August. The first phase of the order has been despatched from Hardall's Luton factory for on-site erection by Hardall personnel in February.

Further enquiries: *Percy Lane Group Ltd., Tamworth, Staffs. Tel. 0827 3821.*

New Exit Signs

Chloride Standby Systems Limited has introduced a new competitively priced range of Bardic self-contained emergency exit signs, listed by the Greater London Council as meeting their standards for safety, durability and performance.

Four versions are available: XL2/M/3T which provides directional lighting at all material times from two integral tungsten lamps (maintained): XL2/NM/3F whose fluorescent tube illuminates only if the mains supply fails (non maintained); XL2/S/3F which includes an additional mains powered fluorescent tube for normal lighting (sustained): and XL2/M/3F the maintained fluorescent version.

All models provide three hours' emergency duration following 24 hours' automatic recharge and two hours' duration after 14 hours' recharge, and feature solid-state circuitry and permanent LED monitoring of ac supply and charger state.

In maintained and sustained models, the normal (mains healthy) lighting can be switched remotely. With fluorescent units, there is no limitation on the distance of the remote switch — enabling central control of all the signs in an auditorium.

All XL2 models are designed for use with self-adhesive legends complying to British Standards BS 5266. Sizes available are 125 mm (5 in) EXIT legend (for 36 m viewing) or 75 mm (3 in) EXIT in conjunction with 25 mm (1 in) EMERGENCY or FIRE legend (for 18 m viewing). Directional arrows can also be fitted if required.

Prices start at £37.50 (plus VAT). Units and legends are available from Bardic Emergency Lighting distributors throughout the UK.

Further information from: *Chloride Standby Systems Limited, William Street, Southampton SO1 1QH. Tel. 0703 30611. Telex 47278.*

The Bardic sign — four versions are available.

Triple-isolated Physiological Pressure Transducer

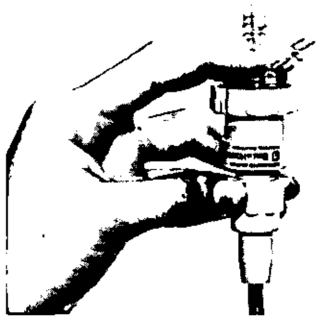
A new physiological pressure transducer is now available from Bell & Howell, Electronics and Instruments Division, which is said to provide exceptionally high levels of patient safety.

Designated type 4—3271, this precision transducer meets the most stringent patient safety regulations and incorporates three levels of isolation to protect the patient from the accidental introduction of an electrical current through the transducer.

The primary isolation between the patient and an electrical hazard are the sapphire rods which support the strain gauge wires and isolate them from the metallic pressure summing diaphragm.

The second level of isolation is the dual high dielectric insulators which surround the strain gauge sensing element to prevent the current from passing between the ground and the patient.

The transducer casing provides the third level of isolation. Type 4—3271 is constructed of non-conducting, self-extinguishing phenylene-oxide plastic. If an electrical current is applied directly either to the case or the dome, it will not be carried to the patient.



The new Pressure Transducer.

Type 4—3271 is calibrated to provide a standard output of 50 μv/V/cm Hg so new transducers can be substituted without recalibration of the monitor or the transducer. Each transducer is also calibrated so that a 178 000 ohm resistor, shunted across the positive excitation and the positive signal (with the transducer balanced at zero pressure), will reflect a 100 mm Hg pressure gain on the monitor.

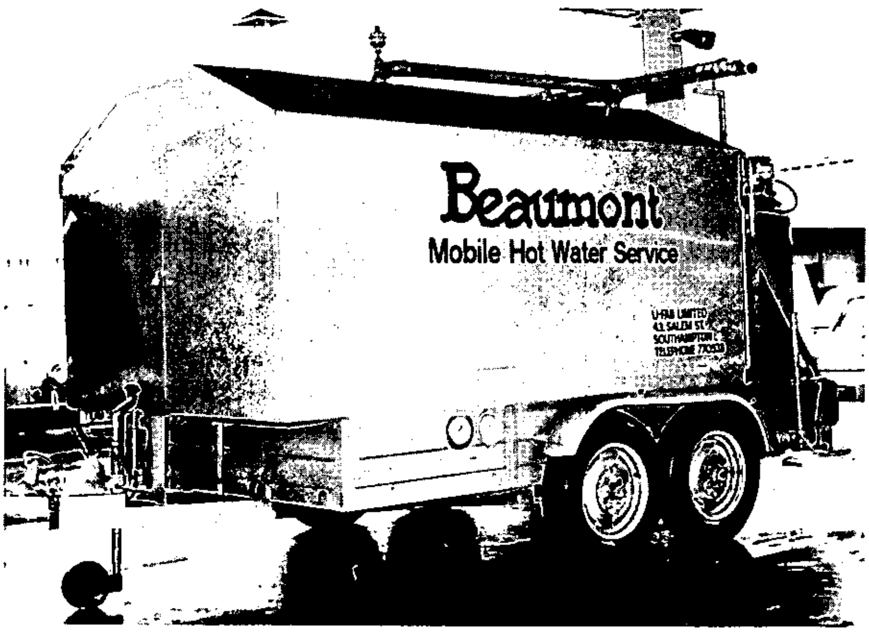
As an alternative to the standard dome, type 4—3271 can be supplied with a 'Disposadome TM', a clear pressure dome incorporating a non-permeable silicon rubber membrane which fits flush on to the sensor diaphragm of the transducer. This build-in membrane provides a sterile barrier between the patient and the transducer. Each 'Disposadome' is pressure tested, 100% inspected, packaged and sterilised.

Type 4—3271 can be sterilised using wet or dry ethylene oxide gas or cold sterilization.

Further information: *Bell & Howell Ltd., Lennox Road, Basingstoke, Hants. Tel. 0256 20244.*

'Portable' Hot Water

The Beaumont, a British designed and built bulk storage water heater, is now available as a fully mobile and weather proof unit requiring connections only to water and electricity supplies. Instant, 'portable' hot water



Hot water 'on tap'.

can be provided for hospitals and institutions, construction industry sites and boiler houses undergoing maintenance — anywhere temporary or standby hot water facilities are required.

Described as a new concept in water heating, the Beaumont ensures cost savings, often as high as fifty per cent, by way of efficient fuel utilisation. Twin burners firing directly into combustion chambers which are actually immersed in the stored water provide consistently high overall efficiency and reduce the stand-by losses normally associated with bulk water heating and storage. Savings have proved considerable where a Beaumont in its static form replaces a central boiler plant, especially during the summer hot water only period, when oversized plant is often used. Siting conveniently near the place of demand and not necessarily with the main boiler installation can provide further economies.

There are 11 gas-fired units available in a range from 300,000 Btu/h, Model 2/30, to the 1 mill Btu/h output, Model 5/100. Once located on site the mobile Beaumont can be secured against interference, and left to provide controllable hot water as the demand requires. Four integrally mounted 104 lb Calor propane cylinders enable the Model 230 to supply 300 gallons of hot water per hour.

In hospitals and institutions the advantages of Beaumont hot water as an instant standby facility are obvious. Heating installers can also ensure a building's essential supply when carrying out routine boiler maintenance or changeover.

There are numerous applications for large volumes of low-cost hot water. The manufacturers will be happy to supply the mobile Beaumont complete, install it on a customer's trailer or just provide the basic storage water heater.

Further information from: *Ufab Ltd., 43 Salem Street, Shirley, Southampton SO1 5QE. Tel. 0703 770533.*

Hospital Kitchen Flooring

After the successful use of Duraflor ACE/6 flooring systems in the upgrading of the Trent Regional Hospital Authority's Mapperley Hospital in Nottingham, further installations have now been made including a new floor at the Harlow Wood Hospital at Mansfield, Notts.

The Hospital's criteria for the new floor were complex — it had to be slip resistant, easy to clean, hard-wearing, resist attack by grease and kitchen waste and — because the floors are suspended — be waterproof.

MBS Resins Limited of Retford topped the underlayment with Duraflor ACE/6 — a resin thin bed Terrazzo, which, although identical in appearance to conventional Terrazzo, is laid to a 6 mm thickness compared with 25-30 mm with conventional materials.

The system was used in all kitchen areas of Harlow Wood Hospital.

Further information: *MBS Resins Ltd., Retford, Notts.*

New Marley Plumbing Technical Paper

Rolf Payne, H.N.Dip., F.I.O.P., M.I. Hosp.E., a leading consultant on drainage systems for hospitals, has written *Sanitary Pipework and Drainage Systems for Health Buildings*, a new Technical Paper sponsored by Marley Plumbing, a division of Marley Extrusions Ltd. This is the second publication in a new series for invited authors, and it covers an area of hospital design where there is a lack of readily available information, to assist plumbing engineers working on health building projects. The paper consists of 36 pages packed with information and diagrams, fully illustrated, and including a number of fold-out plans.

Copies of Marley Plumbing Technical Paper No. 2 are now available, price 75p from: *Marley Extrusions Ltd., Lenham, Maidstone, Kent ME17 2DE. Tel. 0622 54366.*

Free Technical Information – Filters

Moducel, who make a wide range of air handling plant, have found from their experience that there is considerable misunderstanding about air filter performance. Since they do not make filters, but supply proprietary brands to their clients' requirements, Moducel feel they are in a position to give unbiased advice. They have produced a small booklet called 'Common Sense About Air Filters', which describes the various test methods and a guide to the cost effectiveness of different types.

Copies are available from: *Moducel Limited, King Street, Fenton, Stoke-on-Trent ST4 3ES.*

Electronic Information Index

The first 1977 edition of Electronic Engineering Index is available from Technical Indexes Ltd.

The Index gives designers and engineers quick reference to 190,000 pages of technical data from 3,500 companies that manufacture or distribute products for the electronics industry. The designer's search for companies able to supply any specific product is simplified through the 66 charts, analysed under 1,950 different characteristics.

For further information contact: *Technical Indexes Ltd., Easthampstead Road, Bracknell, Berkshire. Tel. 0344 26311.*

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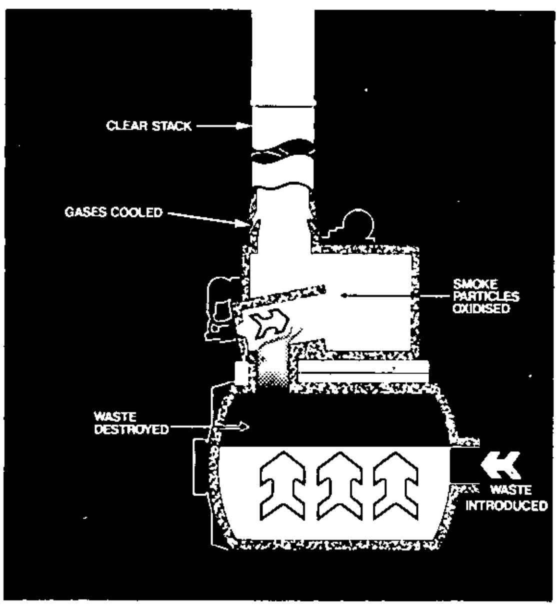

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