MT

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Outbreak of Legionnaire's Disease in Staffordshire

+ other outbreaks around the country

NATIONAL HEALTH

MAY 1985

Referred to	Date	Referred to	Date	Referred to	Date	Referred to	Date
~~20.5.85~~							
~~23.5.86~~							
~~4.6.86~~							
~~17.5.89~~							
~~8.6.89~~							
~~13.6.89~~							
~~29.6.89~~ 18/7/89							

PREM 19/2782

Dd 83 4366 2M 11/83 JET

cc PU

NBPM

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The Rt Hon Norman Fowler MP
Secretary of State for Employment
Caxton House
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18 JUL 1989

Dear Norman,

LEGIONNAIRES DISEASE

I am responding to your letter of ~~17~~ May to Kenneth Clarke.

2. My Department has specific responsibility for school buildings, which are subject to the Schools Premises Regulations 1981. These Regulations closely follow the lines of the general Building Regulations which are the responsibility of the Department of the Environment. So far as Legionnaires disease (LD) is concerned, my Department has advised Local Education Authorities (LEAs) to follow closely the advice in the Health and Safety Executive Guidance Note No EH48, consulting the Local Medical Officer for Environmental Health should any further advice be required. Hitherto LD has not been a serious problem in relation to educational buildings. Very few educational buildings have cooling towers, while the occupants of such buildings are generally among the younger age groups who are less at risk from the disease. But education buildings do generally have large water storage capacities, and often facilities for hot showers. Moreover we are likely to see increasing community use of school buildings, which would expose older people to any risks of LD there might be. My officials have accordingly asked for advice from the Building Research Establishment about the possible incidence of the LD bacteria in educational buildings. I shall arrange for DES to issue further guidance if that seems necessary in the light of BRE advice and the results of other current work, including the responses to the HSC's forthcoming Consultative Document.

3. I do not at present have strong views on whether new general measures, which I take it would be the responsibility of the HSC

under the Health and Safety at Work Act, should take the form of Regulations or of an Approved Code of Practice. So far as educational buildings are concerned, I should have expected that a Code would prove sufficient, given the operation of the Schools Premises Regulations.

4. I am copying this letter to the recipients of yours.

Yours ever

Kenneth

NAT HEALTH: Legionnaires Disease.
Mar 85

NBPM CAS

QUEEN ANNE'S GATE LONDON SW1H 9AT

13 July 1989

Dear Norman,

Thank you for sending me a copy of your letter of 22 May to Kenneth Clarke about Legionnaires' Disease. I thought it would be helpful to circulate a note of the Home Office position.

Your letter was a useful reminder to us to consider the public bodies with which my Department deals. As a result, officials here will be writing to police authorities and chief officers of police, magistrates' courts and probation committees, to bring to their attention the main points of your letter. In addition they will be establishing whether whatever guidance the Department of the Environment may be sending to local authorities leaves any need to provide further guidance to fire and civil defence authorities.

Officials here who are responsible for offering advice to Home Office establishments on these matters are aware of the guidance produced by the Health and Safety Executive, the Department of Health, the Civil Service Occupational Health Service and the Chartered Institute of Building Services Engineers. They have drawn the attention of those Home Office staff with responsibility for maintenance to the guidance available. Internal instructions drawing on the authoritative sources has been produced and will shortly be widely circulated through the Department. Of course, like other Government Departments the maintenance of many of our establishments falls to the Property Services Agency. However, we are conscious of our responsibility to ensure that the proper planned preventative maintenance is undertaken by them.

We note the Health and Safety Commission's plans to issue a Consultative Document and welcome any initiative which the HSC consider necessary to aid prevention of further outbreaks of Legionnaires' Disease. Like colleagues, I am content to await the Commission's advice on whether the new measures should take the form of Regulations or an Approved Code of Practice. However, I share your view that the more flexible ACOP is an attractive idea.

My Department will be interested to see any new solutions for avoiding outbreaks of the disease once the proposed HSE/DH Working Group have made their recommendations.

Copies of this letter go to the Prime Minister, all Cabinet colleagues, Sir Donald Acheson, Sir Robin Butler and Dr John Cullen, Chairman of the Health and Safety Executive.

Yours,

Douglas

The Rt Hon Norman Fowler, MP.

NAT HEALTH: Legionnaire,
May 85

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SECRETARY OF STATE
FOR
NORTHERN IRELAND

The Rt Hon Norman Fowler MP
Secretary of State for Employment
Caxton House
Tothill Street
LONDON SW1H 9NF

29 June 1989

Dear Norman

Thank you for sending me a copy of your letter of ~~22~~ 17? May to Ken Clarke about Legionnaires' Disease.

Here in Northern Ireland we have taken similar action to that contained in your letter to prevent outbreaks of this disease. Other measures - such as the organisation of a seminar and the production of leaflets - have also been put into effect to publicise both the dangers and preventive measures available. All premises with water cooling towers are being identified and the inspection of such premises is underway to check operation and maintenance standards. I am satisfied therefore that all possible steps are being taken by Departments in Northern Ireland to provide information and advice on Legionnaires' Disease not only to public bodies but to the private sector as well.

We must of course guard against complacency, particularly as we have so far escaped outbreaks of the disease here. I welcome, therefore, the decision of the Health and Safety Commission to issue a Consultative Document outlining proposals for strengthening the present arrangements. A requirement to register wet cooling towers would certainly be helpful. On the question of

TK/SOFS/5988

whether new measures should be incorporated in Regulations or an Approved Code of Practice, I would prefer to await the Commissioner's advice before deciding which option to support.

The establishment of a working group to evaluate recent information on Legionnaires' Disease and its prevention is another timely initiative and one in which Northern Ireland Departments would have a particular interest. I am therefore grateful for your assurance that your officials will be in touch with Departments on this matter.

I am copying this letter to the Prime Minister, all members of the Cabinet, Sir Donald Acheson, Sir Robin Butler & Dr John Cullen, Chairman of HSC.

TK

TK/SOFS/5988

NBPM

cc PU

SECRETARY OF STATE

MINISTRY OF DEFENCE WHITEHALL LONDON SW1 2HB

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MO 21/8/5E

13th June 1989

Dear Norman,

LEGIONNAIRES' DISEASE

Thank you for copying to me your letter of 17th May to Kenneth Clarke setting out your proposed approach to the problem of combating Legionnaires' disease.

I have noted the Health and Safety Commission's view that further initiatives to combat the disease are necessary and I would welcome the issue of a Consultative Document setting out the proposed statutory actions to strengthen the existing regime. As for the form the new measures should take, I am inclined to agree that in an area where knowledge is still developing, the more flexible Approved Code of Practice is the more attractive route. However, I would not wish to rule out new Regulations, provided a suitable framework could be developed, and I am content that the Commission advise on this in the light of the consultative process.

At the present time, the Property Services Agency is responsible for the maintenance of the majority of equipment on the Defence Estate which might harbour Legionella and therefore present a risk to health. PSA procedures already cover the requirements

The Rt Hon Norman Fowler MP

SECRETARY OF STATE

contemplated for the new measures. However, I intend to ensure that even as we become less reliant on the PSA and as maintenance work is taken over by private contractors that suitable safeguards are maintained.

My Department has taken steps to increase awareness of preventative measures by issuing a reminder of the guidance currently available in the form of the Health and Safety Executive Guidance Note, the Code of Practice jointly produced by the Department of Health and the Welsh Office, and the guidance issued by the Chartered Institute of Building Service Inquiries. We have placed particular emphasis on the need for an effective management system which clearly shows the chain of responsibility for monitoring preventative action. In addition to these steps, I have also decided that a Defence Council Instruction should be issued drawing attention once again to the risks and the appropriate preventative measures.

I am sending a copy of this letter to the Prime Minister, all members of the Cabinet and to Sir Robin Butler and Dr John Cullen, Chairman of the HSC.

Yours ever,

George.

George Younger

NAT HEALTH: outbreak of
Legionnaires Disease
May 85.

NB PM ctu

ST. ANDREW'S HOUSE
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SECRETARY OF STATE FOR SCOTLAND

The Rt Hon Norman Fowler MP
Secretary of State for Employment
Caxton House
Tothill Street
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SW1H 9NF

8 June 1989

Dear Norman,

at flag

Thank you for copying to me your letter of 17 May to Kenneth Clarke setting out the present position on action to respond to the problem of Legionnaires' disease.

In Scotland, the disease has been notifiable since October last year, and my Department and the HSE work in close co-operation in dealing with outbreaks. In April this year we wrote to all Directors of Environmental Health, and Communicable Medicine Specialists in environmental health, setting out the action which appeared to be necessary to keep the problem under control in Scotland. This included developing and maintaining, in association with the HSE, a non-statutory register of all cooling towers and whirlpool spas, and asking environmental health officers to ensure that a maintenance and disinfection programme acceptable to the HSE is put in place by the owner of each cooling tower or whirlpool spa.

Notwithstanding these developments, I welcome the HSC's proposals to issue a consultative document setting out possible statutory changes; and I would wish the Scottish Home and Health Department to be involved in the proposed joint HSE/DH working group to evaluate recent medical, scientific and engineering information relating to the disease and its prevention. So far as public agencies with whom we have contact is concerned, I agree that those responsible, and those for whom they have responsibility, should be fully aware of the dangers of Legionnaires' disease and the actions necessary to minimise them, and my officials will be considering with the HSE how best to take this forward.

I am copying this letter to the Prime Minister, all Members of the Cabinet, Sir Donald Acheson, Sir Robin Butler and Dr John Cullan.

Yours ever,
Malcolm

MALCOLM RIFKIND

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NAT HEALTH: Legionnaire
May 85

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Secretary of State

Prime Minister ?

The Rt Hon Kenneth Clarke QC MP
Secretary of State for Health
Richmond House
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Dear Ken

Over the last year there has been growing concern about the problem of Legionnaires' disease, with considerable Parliamentary and media attention. In particular, the Employment Select Committee have taken a keen interest in this issue and I am currently preparing my response to their report into last year's outbreak at the BBC. This will reflect the approach set out in this letter.

You may know that I recently met the Chief Medical Officer to discuss the overall problem and possible further Government action. The purpose of this letter is to pull together the various strands so that Cabinet colleagues understand how the issue is being handled, so that we are clear as to our respective roles, and to ensure that we all take appropriate steps against any outbreak in Government buildings.

Legionnaires' disease is a relatively new disease which only came to light in the 1970's. Following the first outbreak within the UK in April 1985 at the Stafford District General Hospital - when 101 people were infected, of whom 28 died - the number of reported outbreaks has apparently increased. This may reflect better identification and greater awareness of the disease rather than a genuine increase, but even so there is clearly a problem which needs to be addressed. There were 70 cases connected to the BBC outbreak in April 1988, of which 3 were fatal, and more recently there have been outbreaks in central London, Knightsbridge, Bolton and Nottingham.

Secretary of State
for Employment

Of course, in spite of these outbreaks the disease remains relatively uncommon - there are about 200-300 cases reported each year, of which some 10-20% are fatal. This compares with about 180,000 of all cases of pneumonia. Nearly 50% of all cases involve infection acquired as a result of travel and many cases are isolated single instances which do not form part of an outbreak. Legionella pneumophilla, the bacterium that causes Legionnaires' disease, is widespread in natural and artificial water sources, and impossible to eliminate completely. It can, however, be controlled, and even where the bacterium is present in large quantities it is only likely to present a risk to health where respirable water sprays and aerosols are created.

Cases of Legionnaires' disease therefore tend to arise from a number of common sources, including water cooling towers associated with air conditioning systems. The majority, although by no means all such installations are to be found in workplaces and therefore fall under the ambit of the health and safety at work legislation.

Principal amongst these is the Health and Safety at Work Act 1974. This places a duty on employers to ensure so far as is reasonably practicable the health and safety at work of all their employees and to conduct their undertakings in such a way as to ensure that the general public are not exposed to health risks. This includes the risk of Legionnaires' disease, and the successful prosecution of the BBC was taken under the HSW Act. In addition, the Control of Substances Hazardous to Health Regulations 1988 (which come into force this October) will apply to the risks of Legionnaires' disease in certain circumstances (eg laboratory work, maintenance of plant).

This general legislation is overseen and enforced by the Health and Safety Commission and their Executive, and they have been active in addressing Legionnaires' disease. In 1987 HSE produced comprehensive and authoritative guidance on Legionnaires' disease and in January 1989 they published a free plain language leaflet summarising the precautions. I know that your department has also produced practical advice on the control of legionellae in health care premises.

Wherever possible, HSE draw attention to the issue of Legionnaires' disease, the legislation and the available guidance. Inspectors raise the problem during preventive inspections, and take enforcement action where companies do not measure up to the required standards. The Executive have said that now that fair and general public warning has been given they will in future tend towards recommending Magistrates to refer such cases to the higher courts.

Action has also been taken to ensure that Local Authority Inspectors, who enforce health and safety legislation in certain premises (eg offices, shops), are aware of existing instructions on Legionnaires' disease. Furthermore, HSE are planning a major national conference to be held jointly with the Public Health Laboratory Services later this year.

The Government has so far maintained that Legionnaires' disease is containable so long as existing guidance is followed and proper precautions taken, and that existing law is adequate to allow any enforcement which is necessary. I still believe this line to be tenable, and that it is right for HSC to take the lead in advising how the problem can best be dealt with. However, there is a case for greater efforts to be taken to publicise the problem and existing guidance, and also to make the legal position more clearly understood.

There are two elements to this. Firstly, HSC have recently reviewed their policy on Legionnaires' disease. This review was carried out in the light of the recent series of outbreaks and concluded that whilst existing laws and guidance are sufficient for practical and enforcement purposes, further initiatives are necessary and would be profitable. HSC have therefore decided to issue a Consultative Document containing proposals for statutory actions to strengthen the existing regime. These would apply to a prescribed list of installations, including wet cooling towers known to be associated with incidents of the disease. The measures, which would both reinforce the general duties of the HSW Act and support technical guidance, would include the following requirements:

- regular maintenance, cleaning and treatment of scheduled installations;

- maintaining and keeping of written records;

- appointment of a suitable person to be responsible for the necessary precautions being taken;

- responsibilities of manufacturers, suppliers and designers of scheduled installations.

The consultative exercise will seek views on whether wet cooling towers should be registered, and I am writing separately to Nicholas Ridley on the possibility of banning the construction of new wet cooling towers in urban areas. The consultation will also canvass opinions on whether the new measures should take the form of Regulations or an Approved Code of Practice (ACop). The attraction of the latter is that

Secretary of State
for Employment

it has the force of law yet is more flexible, and may therefore be more suited to an area where the state of knowledge is still developing. The Commission will advise as to which is more appropriate in light of the consultation, but I should welcome any comments you or colleagues may have on the relative merits of an ACop or regulations.

HSE are also currently discussing with your officials the establishment of a joint HSE/DH working group to evaluate the most recent medical, scientific and engineering information relating to the disease and its prevention, and to consider longer term solutions that might need to be taken. Clearly, other departments will also need to be involved in this group and officials will be in touch.

This work by HSC effectively covers the general questions of legislative and administrative action for the time being. But it leaves the specific questions of what else we in Government should be doing to ensure that the problem is effectively countered and contained, and this is the second area for action.

Government is responsible not only as an employer for a large number of premises and the safety of their occupants, but also for a large number of public agencies (for example public health authorities, education authorities, local authorities). It is essential that we each take action to ensure that those responsible, and those for whom they have responsibility, are fully aware of the dangers of Legionnaires' disease and the actions necessary to minimise them. I do not need to stress the potential embarrassment that would be caused were a government department found to be ignoring the advice that we are so vigorously publicising. I therefore invite you to arrange for your own officials to put any necessary steps in hand, or indeed you and colleagues may consider it appropriate to write personally to larger public bodies for which your departments have responsibility.

Copies of this letter go to the Prime Minister, all members of the Cabinet, Sir Donald Acheson, Sir Robin Butler and Dr John Cullen, Chairman of HSC.

NORMAN FOWLER

Legionnaire's Disease (Badenoch Report)

3.52 pm

The Minister for Health (Mr. Barney Hayhoe): With permission, Mr. Speaker, I will make a statement about the first report of the Badenoch committee of inquiry into the outbreak of legionnaire's disease in Stafford.

The outbreak at Stafford district general hospital occurred in April 1985: 101 patients caught the disease and there were 28 deaths. This was the second most serious incident ever recorded, surpassed only by the outbreak in Pennsylvania in 1976 from which the disease was first recognised. The source of infection was traced to the air conditioning system. My right hon. Friend the Secretary of State for Social Services appointed a statutory public inquiry on 7 June 1985, chaired by Sir John Badenoch.

The inquiry has produced a first report covering the Stafford outbreak and has also made recommendations more generally about hospital air conditioning systems. The inquiry will now consider and make recommendations on action to reduce the possibility of future outbreaks, whether in hospitals, other buildings or elsewhere, and the Government expect to receive this second report around the turn of the year. The first report concludes that, on present knowledge, the outbreak at Stafford cannot be attributed to any single factor, nor does it hold any individual or group directly responsible. It points out that legionnaire's disease has only recently been identified and is not well understood. The report refers to a combination of circumstances which appear to have contributed to this outbreak.

These circumstances include defects in the design and construction of engineering services, problems during the commissioning of the air conditioning plant, lack of knowledge and understanding of the sophisticated engineering plant, shortcomings in maintenance, including chlorination, and the weather conditions. The report also points to the inherent difficulty on present knowledge of eliminating the legionella bacillus in water spray cooling towers used for air conditioning.

The report praises those who cared for the infected patients and I gladly endorse this tribute. The report makes recommendations specific to the circumstances surrounding the outbreak and requiring local action. In particular, it calls for a review of the health authority's microbiological services in Stafford. I am asking the West Midlands regional health authority and the Mid-Staffordshire district health authority to report within three months on the follow-up action they have taken or intend to take.

Revised guidance on the maintenance of cooling towers was issued to health authorities in January 1986 following consultation with Sir John Badenoch. This reflects the lessons learned at that stage from the inquiry. In the light of the completed report, the Department has today issued a further circular to health authorities asking them to check for features similar to those found at Stafford and to take appropriate action. They are also being asked to ensure that existing guidance on maintenance is being followed and that operational engineering staff have access to detailed guidance on the operation of individual water spray cooling systems.

The recommended code of practice for hospital engineers should be available by about the end of the year. In the meantime, discussions are in hand with the Public Health Laboratory Service to establish a register of engineers so that relevant expertise can be available if needed by the Communicable Disease Surveillance Centre and health authorities.

The inquiry recommended that a committee of experts should be convened urgently to consider all aspects of the use of biocides as a means of minimising build up of legionella. This committee will be chaired by Dr. A. E. Wright, director of the Public Health Laboratory Service Newcastle laboratory, and will begin its work shortly.

Other recommendations dealt with reducing reliance on air conditioning in general and water spray cooling towers in particular. Current hospital building policy, with its emphasis on smaller hospitals, means that new hospitals generally use less air conditioning than before. Preliminary inquiries indicate that no new water spray cooling towers will be incorporated in hospitals currently being planned. The inquiry's conclusions will reinforce the commitment to air-cooled systems for new hospital building.

As regards existing hospitals, health authorities have been asked to give details about the type and number of water spray systems now in use, as a first step to carrying out the recommendation that urgent consideration should be given to their replacement. Only a minority of hospitals are thought to have such systems, but the inquiry will establish an accurate national picture. I understand that the inquiry team did not envisage immediate replacement of such systems; it was concerned to ensure that existing systems operate as safely as possible and those which have reached the end of their natural life or present particular maintenance problems should have priority for replacement.

Early action was taken with the two health notices in July 1985 and January 1986 and further instructions, based upon this first report, have now been issued to health authorities. These steps will reduce the risk of any repetition of the outbreak. Production of a code of practice and setting up the register of engineers experienced in this field will also contribute to that end. In the longer term, the new committee on biocides should help to clarify how these chemicals can best be used to reduce risks further. Information is being collected about existing hospital water spray cooling systems as a first step in the consideration of their longer-term future.

We owe a great deal to Sir John Badenoch and his fellow inquiry members for the energy and application they have brought to producing this report. For the broader questions about what may need to be done to reduce any risk from the disease in other circumstances in hospitals, other buildings and elsewhere, the Government look forward to the second report, which is expected around the turn of the year.

Mr. Frank Dobson (Holborn and St. Pancras): I join the Minister in thanking Sir John Badenoch and his colleagues for the work that they have done in the inquiry. As the Minister has said, the findings of the committee has revealed a considerable number of shortcomings. There are many uncertainties surrounding even that which happened at Stafford, and there are even more uncertainties about the knowledge, development and spread of legionnaire's disease generally.

[Mr. Frank Dobson]

Even the first report has implications for other hospitals in other areas, and it is not entirely clear from the Minister's statement whether the Government fully accept all the recommendations within it. I should like the Minister to be specific about that. Will he tell us whether the Government intend to find the extra staff and money that will be necessary for the investigation of the cooling systems at other hospitals and for any adaptations and replacements that may be necessary?

Does the Minister accept the committee's recommendation that there should be further research into legionnaire's disease? If he does, is he satisfied that there are presently only two Government-funded research projects into legionnaire's disease? Given the tribute that has been paid to the Public Health Laboratory Service and the Communicable Disease Surveillance Centre in the report, will he reaffirm that the Government have abandoned any intention of interfering with the Public Health Laboratory Service, or to abolish it or the Communicable Disease Surveillance Centre, which were around at the time of the outbreak.

Although this is not covered by the report, I should like to know whether the final report will cover the action taken by the Minister's Department? To be fair to the Minister, that was action taken before he became the Minister for Health. Is the right hon. Gentleman satisfied that no fewer than five days elapsed between his office at the Elephant and Castle being informed that the Stafford hospital people believed that legionnaire's disease was caused by their water cooling system and the Department informing other health authorities with hospitals with identical cooling systems of what had happened at Stafford?

Mr. Hayhoe: I am grateful for the hon. Gentleman's comments about Sir John and his colleagues. As a first step towards achieving urgent consideration about whether to replace existing spray systems, we have called for the establishment of the precise situation throughout the country. I understand that there are about 400 water spray cooling towers now in place, and we shall need to consider the details of the installations.

The assessment of where we stand can be undertaken notwithstanding resource implications within existing budgets. The immediate priority for health authorities must be to ensure that the existing equipment is correctly and safely maintained. These instructions have already gone out and they will be reinforced by the publication of the report and by the further health notice which is being issued.

Legionnaire's disease is affecting countries throughout the world and I am not aware of any research projects that are not being followed through. I would be prepared to give consideration to any suggestions that come forward and to pass them on to those responsible for medical research.

The hon. Gentleman made some rather exaggerated comments about the Public Health Laboratory Service and a report which was produced earlier this year. My right hon. Friend the Secretary of State made it clear quickly that he did not accept the proposals in the report and that he wished the service to continue in its existing form. My right hon. Friend's clear undertaking remains.

The content of Sir John's final report will be a matter for him and his colleagues and not for me.

Mr. William Cash (Stafford): I welcome my right hon. Friend's statement, the Badenoch report and the Government's immediate response last year to my call for a full independent inquiry, but will my right hon. Friend accept that some serious criticisms are contained in the report that show that the sort of action that is outlined in the report is necessary? Will he join me in extending sympathy to those who were bereaved during the course of the outbreak of legionnaire's disease in my constituency? Will he ensure that appropriate praise is given to the nursing staff for the wonderful work that it conducted in difficult and dangerous circumstances while the outbreak was continuing?

Mr. Hayhoe: Yes, I join my hon. Friend in his expressions of sympathy, which have been made in the House before and which, I am sure, will be reiterated in all parts of it, to the relatives and friends of those who suffered. I endorse the tribute which was paid in the report and paid previously by my predecessor and by the hon. Member for Holborn and St. Pancras (Mr. Dobson) to the staff. Anyone who reads the report of the inquiry will see that tribute is paid in unstinted fashion to those who had the care of the patients who, alas, suffered from this serious infection. I congratulate my hon. Friend, whose assiduous attention to detail as the constituency Member has rightly won admiration and praise in all parts of the House.

Mr. Archy Kirkwood (Roxburgh and Berwickshire): I associate my right hon. and hon. Friends with the comments that have been made about the sympathy that we should extend to the relatives of those who died in this tragic incident and the tribute that we should pay to the heroic efforts of the staff who put it right. We owe a debt to Sir John Badenoch for the expedition with which he has produced the report.

Can the Minister confirm that DHSS maintenance standards for the cooling towers are upheld and that the proper recommended procedures are followed? I understand from his statement that he found that there were maintenance defects. Has he considered the use of biocides such as Hatacide LP5 as a replacement for chlorination, as chlorination has been found to be defective, and certainly in the conditions found in modern water spray cooling systems?

Secondly, the Minister will know from the expert advice that he has been receiving that old people are especially vulnerable to legionnaire's disease. He has said that 400 institutions have water spray cooling systems, and I ask him to give especial attention and priority to those that accommodate elderly people, who are particularly at risk. If he finds that there are still suspect systems, will he ensure that no expense is spared in replacing equipment?

Mr. Hayhoe: I am grateful to the hon. Gentleman for what he has said about extending sympathy to the relatives of those who died. He has addressed himself to the maintenance of the air conditioning plant at Stafford and, as I said earlier, the report reveals a number of defects in design, installation, maintenance and chlorination which appear to have contributed to the outbreak of the disease. The inquiry was not able to point the finger precisely at any one specific failure or cause. The infection appeared to start on 9 April and appeared to cease on 19 April. The cessation may have been contributed to by a change in weather conditions, but there is still no absolutely clear reason why the outbreak started and why it ended.

The way in which infections of this particular organism have been found to operate in different parts of the world at different times makes it extremely difficult to be precise and specific about the causes. The hon. Gentleman has referred to the use of biocides and he will have heard me say that we have accepted the recommendation that an expert committee should consider the issue. I have said that Dr. Wright, who is a distinguished expert in this area, will be chairing the committee. I hope that the membership of it will be established pretty soon and that it will get to work without delay.

The hon. Member for Holborn and St. Pancras (Mr. Dobson) was right to draw attention to the vulnerability of old people to infection. People who have suffered from chronic infections and, indeed, those who have been heavy smokers also appear to be vulnerable. They all appear to be more liable to be adversely affected by the infection. The hon. Gentleman's point about the water spray cooling towers, and their relationship to institutions where there are people with particular vulnerability, such as the old, will be taken into account.

Mr. John Heddle (Mid-Staffordshire): May I associate myself with my right hon. Friend's kind and generous remarks about the care bestowed by the staff at Stafford hospital, particularly the care for my constituents, who are just five miles away from Stafford hospital? Will my right hon. Friend confirm that also about five miles away is Meaford power station? Have he and the inquiry completely eliminated the possibility of a correlation between the water cooling system of Meaford power station and legionnaire's disease? Has my right hon. Friend satisfied himself that the committee has ensured, through any consultations that it may have had with the Central Electricity Generating Board and others, that there was no connection? Will he confirm that the most rigorous inquiry has taken place as to the efficacy of the water cooling system at Stafford general hospital and, indeed, the quality of maintenance of the water cooling system?

Mr. Hayhoe: I am grateful to my hon. Friend for his comments and his endorsement of the tribute to the staff concerned. He will have personal knowledge of that because some of his constituents were affected. A connection with the water cooling systems in nearby power stations has not been established, nor, I suggest —although I do so subject to correction—has it been totally eliminated. As far as I can judge from the scientific and engineering evidence that is coming forward, it is extremely difficult to be absolutely positive either for or against any proposition in this area. It has become clear that the organism that led to the deaths and illness of those affected in the outbreak was identified as being in the air conditioning system. Cooling tower No. 4 had a connection with the outpatients' department where, as far as one can judge, the majority of those who were affected picked up the infection.

Mr. Jeremy Corbyn (Islington, North): What steps will be taken to ensure that employees of the National Health Service are made aware of the contents of the Badenoch report, and what steps will be taken to ensure that sufficient training is given to staff in the NHS to overcome any problems arising from the changes that will be necessary as a result of the recommendations in the report?

Secondly, will the right hon. Gentleman assure the House that any changes that have to be made to NHS equipment in any hospital as a result of the report will be paid for out of central funds, not out of local district health authority funds, so that they will not be set against the costs of existing services and staff?

When the final report is ready, and if any changes are required in building control regulations for any other building or installation, will the right hon. Gentleman ensure that the Department of the Environment introduces the necessary building control regulations for any new central heating or water cooling systems rather than awaiting another disaster such as the one that we have already had in the NHS?

Mr. Hayhoe: The general tenor of the hon. Gentleman's remarks is much less than fair to the very careful preparation that has been done in the past to give guidance on the dangers and difficulties associated with the disease. I checked the experience in other countries, and I found that the guidance that was issued by the NHS in this country was in advance of that issued anywhere else in the world. We should take pride in the fact that NHS staff have been out in the front and leading internationally in dealing with this difficult infection.

With regard to passing on information, the report is going to all health authorities. No doubt, in their own circumstances, they will let all those concerned know. There are recommendations in the report about the need for further training and, of course, it will be carried through.

Several Hon. Members *rose*——

Mr. Speaker: Order. I must have regard to subsequent business on the Order Paper. This statement is about the inquiry into legionnaire's disease in Stafford. Will hon. Members direct their questions to that and not widen the issue?

Mr. Peter Bruinvels (Leicester, East): As I have two hospitals in my constituency—Leicester general and the Towers hospital — will my right hon. Friend assure constituents and the elderly——

Mr. Speaker: Order. That is what I was hoping would not happen.

Mr. Bruinvels: Will my right hon. Friend ensure that there is wide circulation of the Badenoch report so that elderly people in the country, including Stafford, realise that when they go into hospital they will be properly cared for and that health and safety will be maintained throughout? Will he further ensure that the report will be distributed not just to the health authorities but to those who are particularly concerned—the elderly?

Mr. Hayhoe: I can assure my hon. Friend that the report will go to all the health authorities, and indeed it has been circulated among Government colleagues and, I am pretty sure, to the professional institutions and others involved. I imagine that within the scientific and engineering community with particular concern for those systems the report's recommendations will be studied with care. The guidance that my Department will issue to all health authorities will also be made available to anyone else outside who has an interest and who asks for it.

Mrs. Gwyneth Dunwoody (Crewe and Nantwich): Is not the Minister aware that it was precisely because it was impossible to isolate the true origin of the epidemic at Stafford that there was considerable disquiet in the area? Will he please understand that what is required now is urgent action in relation to the other hospitals with comparable systems? That requires central funding. It is not enough to send out a circular. Those hospitals must be given money immediately so that they can do something about their existing systems.

Mr. Hayhoe: The hon. Lady slightly misunderstands the position. Guidance about existing systems has been available since 1980, and it was reinforced in July 1985 and January 1986. The hon. Lady does a grave disservice if she is trying to show that a shortage of finance is connected with the difficulties. If she reads the report, she will see that lack of finance was in no way involved.

Mrs. Ann Clwyd (Cynon Valley): The Minister has talked about specific recommendations for hospitals, but I suggest that an outbreak could occur in air conditioning systems in other public buildings, unless proper maintenance of the systems is carried out. The remit of any committee that the right hon. Gentleman sets up should include aspects of air pollution through air conditioning systems and its effect on health. More people are recognising the link between air conditioning systems and absenteeism from work, with more infections — *[Interruption.]* But it is important that any committee——

Mr. Speaker: Order. I am sure that it is important, but will the hon. Lady please concentrate on the statement?

Mrs. Clwyd: I am attempting to do so, Mr. Speaker, by showing that legionnaire's disease could occur in any public building unless there is proper control of air conditioning systems. Any committee that the Minister intends to set up should have a much wider remit than what he has suggested so far.

Mr. Hayhoe: The hon. Lady must have misunderstood what I said. She will understand when she reads the report. Sir John Badenock's committee has produced a first report dealing with the Stafford incident in particular. I said that there would be a second report, which would look at what could be done to reduce any risk from the disease in other circumstances, in hospitals or other buildings, whether in the public or private sector, and elsewhere. Even the possibility of the infection on ships has already been identified. Sir John and his colleagues are going ahead with that wider work and their report can be expected towards the end of the year.

Mr. Greville Janner (Leicester, West): Has the Minister considered paragraph 52 of the report? It says that one of the ways in which the dissemination of this disease is known to occur is

"via shower heads or spray taps (which are used intermittently, and where the organism may multiply if the water is warm) . . ."

Bearing in mind that the Select Committee on Employment, on which I have the privilege to serve, looked into the problems of this disease and considered evidence to the effect that it also arises from whirlpools and Jacuzzis and in other precise systems where water goes into the air, will the Minister direct the inquiry specifically to those problems? Apparently no prosecutions are to arise from the current disasters. Can the Minister tell the House whether as a result of this inquiry and the miseries which gave rise to it steps will be taken to remove Crown immunity in respect of any such further incidents which may involve liability by hospitals or prisons or any other public institution? That immunity should have been removed long ago.

Mr. Hayhoe: Crown immunity has absolutely nothing to do with this. If compensation is paid as a result of this inquiry and this incident, it will be a matter for the Mid Staffordshire health authority operating under our regulations, and in the final analysis it will be a matter for the courts to determine. I can give the hon. and learned Member the assurance that Crown immunity will not come into that.

The hon. and learned Gentleman directed my attention to a paragraph in the report and seemed to be suggesting that I should draw Sir John's attention to that paragraph so that he and his colleagues could carry out further work. Sir John and his colleagues hardly need me to draw their attention to what they have written so that they can decide upon their further work. As I have said, that work will be wide ranging and Sir John and his colleagues will look at the action that will be required to reduce the possibility of this infection arising in hospitals, in other buildings or elsewhere. Sir John and his colleagues have taken a fairly wide remit.

Mr. Gareth Wardell (Gower): This important report demonstrates the difficulty of explaining why legionnella bacilli multiply. In following up the report, will the Minister ensure that a careful look is taken at the extent to which the problem could arise because of products being used in the manufacture of drainage systems, air cooling towers and so on that do not comply with the BSI standard, especially if such products are imported?

Mr. Hayhoe: I am sure that Sir John and his colleagues will wish to look at that matter.

The hon. and learned Member for Leicester, West (Mr. Janner) spoke about other buildings. I have checked and found that the air conditioning system in the Houses of Parliament does not have a water spray system.

Dr. John Marek (Wrexham): May I refer the Minister to the recommendations of the report and especially to recommendation 8(a) on page 64? It says:

"urgent consideration should be given to replacing any wet cooling tower with an air-cooled system".

That will involve finance. Can the Minister say whether finance will be provided and, if so, whether it will come from central funds?

Mr. Hayhoe: The report says that urgent consideration should be given to those matters and as a first step towards giving that consideration we have called for information about the systems in use. That information will need to be considered. As I have said, the immediate priority must be to ensure tha the existing equipment is correctly and safely maintained. Of course it will cost money to replace water spray cooling towers. It is clear that the inquiry did not recommend immediate replacement of such systems, and in any case the replacement of towers that are at the end of their lives will cost money.

In planned hospital building for the future we have, fortunately, turned to air cooling rather than water spray cooling and we will look into the problems identified by the survey that has been initiated about dealing with existing water spray cooling towers. If that involves significant cost, then, of course, the matter will be looked at. Changing circumstances are always looked at in the context of the ways in which we fund the National Health Service.

Mr. Frank Haynes (Ashfield): On a point of order, Mr. Speaker. Earlier today we had a statement about the resignation of Mr. Victor Paige. I asked the Secretary of State a question. I am not suggesting that his reply was a lie, but I am suggesting that we should have fairness and I know that you, Mr. Speaker, try to ensure that. The Secretary of State said that the Committee which considered the Social Security Bill sat for three months. That is correct, and I never missed a sitting. He said that I suggested things in the Committee with which he totally disagreed. The Secretary of State was hardly ever there. May I suggest that you, Mr. Speaker, have a word with the Secretary of State to sort things out?

Mr. Speaker: I thought that the hon. Gentleman had asked for the Minister's resignation.

Mr. Jeremy Corbyn (Islington, North): On a point of order, Mr. Speaker. We have had an important statement about legionnaire's disease at Stafford hospital, and implications for local health authorities clearly arise from the statement. The Minister has not answered the serious question about how the local authorities are to fund the cost of implementing the recommendations in the report. Can you advise me, Mr. Speaker, by what means we can get a clear answer from the Government about this important matter that is causing many health authorities a great deal of worry?

Mr. Speaker: I called the hon. Gentleman to ask a question, but I do not know whether it was fully answered. There are other ways in which the hon. Gentleman can deal with the matter. He can deal with it at Question Time or even by way of an Adjournment debate if he is fortunate enough to get one.

BILL PRESENTED

Tobacco Products (Health Warnings)

Mr. Archy Kirkwood, supported by Mr. Roger Simms and Mr. Laurie Pavitt presented a Bill to provide for the presentation of health warnings on packaging of tobacco products, and related advertising and promotional materials: And the same was read the First time; and ordered to be read a Second time on Friday 4 July and to be printed. [Bill 170.]

Road Traffic Accidents Compensation for Victims

4.28 pm

Mr. Greville Janner (Leicester, West): I beg to move,

That leave be given to bring in a Bill to provide compensation for victims of road traffic accidents wthout proof of fault and for related purposes.

The casualty toll on our roads is horrific, and from figures supplied to me last week in a written answer it appears that in the last four years for which records were available 1,251,000 of our citizens were injured in road accidents. Of those, 682,000 were men, 380,000 were women and 189,000 were children. We know from the researches carried out by the Royal Commission on civil liability and compensation for personal injury, chaired by Lord Pearson, and known as the Pearson commission, that only a fraction of those who are injured on our roads receive any compensation through the ordinary provisions of the law on tort, a law which requires those who seek damages to prove negligence against the defendant. The report said:

"only about a quarter of those who are injured by motor vehicles actually succeed in recovering tort compensation".

The manner in which it is decided whether someone who is injured on the road is to get compensation is archaic, ridiculous and does not work. It is a form of legal lottery, or, as the Pearson commission said:

"the fault principle operates with particular capriciousness. The 'forensic lottery' had become 'a lunatic lottery and an absurd system for providing compensation for anyone.'"

The system denies compensation to most people and ensures that in most cases those who obtain compensation are kept waiting for a long time for the money that they so desperately need.

It is the purpose of this Bill to introduce into our law the concept of no-fault liability in respect of road traffic accidents. It would ensure that when a case comes to court years after an accident people are not called upon to give evidence about what happened in a split second, which, even immediately afterwards, they cannot remember with any certainty, that they are not cross-examined in court about matters which occurred when they were suffering from shock, and even if they are trying to tell the truth —most are—will fail to do so, that matters which rely on personal recollection and not upon documentation, but upon which people's entire financial futures depend, will not be matters for courts, and that people who are entitled to be compensated will obtain that compensation without having to prove negligence.

The concept is not new in our law. Under the Employers Liability (Defective Equipment) Act 1969, when an employee is injured or killed at work because of defective equipment, and in a subsequent action the employer is deemed to have been negligent, liability is imposed without fault. The House has accepted and approved a directive of the European Economic Community regarding product liability, and the Government are therefore committed to introducing legislation that will bring no-fault liability into our law in respect of defective products. If a product is manufactured in or imported into Britain after the summer of 1988 and it is defective and the defect causes death or personal injury, the sufferer will not have to prove negligence against the defendant—it will be presumed. The Bill would introduce precisely the same concept into the much

[Mr. Greville Janner]

larger, broader, more anguished and common area of road traffic accidents, in respect of which 250,000 families are affected each year by the nonsense and lack of sense and compassion of the law as it stands.

Strangely enough, matters are getting steadily worse. In Leicestershire, for example, the number of people killed on the county's roads during the first three months of this year was almost double that for the same period in 1985. Seat belts have done some good, but they have not removed the miseries of the road casualty. The Bill would provide for no-fault liability.

The question that would then arise is, who would pay for the reform? Part of the problem is that a private Member's Bill cannot involve public expenditure, because that is contrary to the rules. Part of the answer lies in the removal from lawyers and courts of cases which could properly be dealt with through a different and much less expensive system. Money would therefore be saved. Part of the answer may lie in the system which exists in New Zealand and which, I am told, is to be introduced in Australia. The state operates a scheme with or without insurance companies. The answer may lie in the insurers bearing the cost, as part of the cost would be saved by their not being forced into litigation, courts and unworthy and unnecessary costs. Part of the cost might be added to insurance premiums. I reckon that most motorists would be pleased to pay that price if it meant that, in the event of an accident, they would stand a chance of getting compensation such as is denied to them at present.

I wish to pay tribute to the memory of Lord Pearson, a man for whom I had enormous affection and respect. I wish that his report in this respect had not been hidden away since 1979-80. At least this Bill will bring to the attention of the House, the Government and the public the fact that the forensic lottery must end. That was the Pearson commission's description of this unduly slow and expensive to administer system. One day, some 45 per cent. of the cost of tort compensation will cease to be swallowed in administration costs and people will get the compensation to which they are entitled.

If the House accepts the Bill, it will add to people's prospects of getting justice. As the Pearson commission said in respect of product liability, there is no justice in our courts for most of our citizens. Those who are poor enough to get legal aid can bring a case to court, those who are rich enough not to need it may sue or defend, but for those who, like most of us, come somewhere in between, there is no hope of fighting a case. That is why some three quarters of accident victims who deserve compensation get none. In those circumstances, I hope that the House will give me leave to introduce the Bill as the start of a campaign which I trust will end as did the product liability campaign—with a change in the law.

Question put and agreed to.

Bill ordered to be brought in by Mr. Greville Janner, Mr. Stuart Bell, Mr. Gerald Bermingham, Mr. Tony Blair, Mr. Gordon Brown, Mr. Alfred Dubs, Mrs. Gwyneth Dunwoody, Mr. Frank Field, Mr. Ron Leighton and Mr. Geoffrey Robinson.

ROAD TRAFFIC ACCIDENTS COMPENSATION FOR VICTIMS

Mr. Greville Janner accordingly presented a Bill to provide compensation for victims of road traffic accidents without proof of fault and for related purposes: And the same was read the First time; and ordered to be read a Second time upon Friday 4 July and to be printed. [Bill 169.]

Building Societies Bill [Money] (No. 2)

Queens Recommendation having been signified—

Ordered,

That, for the purpose of any Act resulting from the Building Societies Bill, it is expedient to authorise the payment out of money provided by Parliament of any expenses incurred by the Treasury for the purposes of tribunals established in pursuance of that Act to hear appeals against decisions of the Building Societies Commission established by that Act relating to the authorisation of building societies to raise funds and borrow money.—*[Mr. Ian Stewart.]*

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Political

STATEMENT

With permission, Mr Speaker, I will make a statement about the First Report of the Badenoch Committee of Inquiry into the outbreak of Legionnaires' disease in Stafford.

The outbreak at Stafford District General Hospital occurred in April 1985. 101 patients caught the disease and there were 28 deaths; the second most serious ever recorded, surpassed only by the outbreak in Pennsylvania in 1976 from which the disease was first recognized. The source of infection was traced to the air conditioning system. My Rt Hon Friend the Secretary of State for Social Services appointed a statutory public inquiry on 7 June 1985, chaired by Sir John Badenoch.

The Inquiry has produced a First Report covering the Stafford outbreak and has also made recommendations more generally about hospital air conditioning systems. The Inquiry will now consider and make recommendations on action to reduce the possiblity of future outbreaks, whether in hospitals, other buildings or elsewhere, and the Government expect to receive this Second Report around the turn of the year.

THE FIRST REPORT CONCLUDES THAT, ON PRESENT KNOWLEDGE, THE OUTBREAK AT STAFFORD CANNOT BE ATTRIBUTED TO ANY SINGLE FACTOR NOR DOES IT HOLD ANY INDIVIDUAL OR GROUP DIRECTLY RESPONSIBLE. IT POINTS OUR THAT LEGIONNARIES' DISEASE HAS ONLY RECENTLY BEEN IDENTIFIED AND IS NOT WELL UNDERSTOOD. THE REPORT REFERS TO A COMBINATION OF CIRCUMSTANCES WHICH APPEAR TO HAVE LED TO THIS OUTBREAK.

THESE CIRCUMSTANCES INCLUDE DEFECTS IN THE DESIGN AND CONSTRUCTION OF ENGINEERING SERVICES, PROBLEMS DURING THE COMMISSIONING OF THE AIR CONDITIONING PLANT, LACK OF KNOWLEDGE AND UNDERSTANDING OF THE SOPHISTICATED ENGINEERING PLANT, SHORTCOMINGS IN MAINTENANCE INCLUDING CHLORINATION AND THE WEATHER CONDITIONS. THE REPORT ALSO POINTS TO THE INHERENT DIFFICULTY ON PRESENT KNOWLEDGE OF ELIMINATING THE LEGIONELLA BACILLUS IN WATER SPRAY COOLING TOWERS USED FOR AIR CONDITIONING.

THE REPORT PRAISES THOSE WHO CARED FOR THE INFECTED PATIENTS AND I GLADLY ENDORSE THIS TRIBUTE. THE REPORT MAKES RECOMMENDATIONS SPECIFIC TO THE CIRCUMSTANCES SURROUNDING THE OUTBREAK AND REQUIRING LOCAL ACTION. IN PARTICULAR IT CALLS FOR A REVIEW OF THE HEALTH AUTHORITY'S MICROBIOLOGICAL SERVICES IN STAFFORD. I AM ASKING THE WEST MIDLANDS RHA AND THE MID-STAFFORDSHIRE DHA TO REPORT WITHIN THREE MONTHS ON THE FOLLOW-UP ACTION THEY HAVE TAKEN OR INTEND TO TAKE.

Revised guidance on the maintenance of cooling towers was issued to Health Authorities in January 1986 following consultation with Sir John Badenoch. This reflects the lessons learned at that stage from the Inquiry. In the light of the completed Report, the Department has today issued a further Circular to Health Authorities asking them to check for features similar to those found at Stafford and to take appropriate action. They are also being asked to ensure that existing guidance on maintenance is being followed and that operational engineering staff have access to detailed guidance on the operation of individual water spray cooling systems.

The recommended Code of Practice for Hospital Engineers should be available by about the end of the year. In the meantime, discussions are in hand with the Public Health Laboratory Service to establish a Register of Engineers so that relevant expertise can be available if needed by the Communicable Disease Surveillance Centre and Health Authorities.

The Inquiry recommended that a Committee of experts should be convened urgently to consider all aspects of the use of biocides as a means of minimising build-up of Legionella. This Committee will be chaired by Dr A E Wright, Director of the Public Health Laboratory Service Newcastle Laboratory, and will begin its work shortly.

OTHER RECOMMENDATIONS DEALT WITH REDUCING RELIANCE ON AIR CONDITIONING IN GENERAL AND WATER SPRAY COOLING TOWERS IN PARTICULAR. CURRENT HOSPITAL BUILDING POLICY WITH ITS EMPHASIS ON SMALLER HOSPITALS MEANS THAT NEW HOSPITALS GENERALLY USE LESS AIR CONDITIONING THAN BEFORE. PRELIMINARY ENQUIRIES INDICATE THAT NO NEW WATER SPRAY COOLING TOWERS WILL BE INCORPORATED IN HOSPITALS CURRENTLY BEING PLANNED. THE INQUIRY'S CONCLUSIONS WILL REINFORCE THE COMMITMENT TO AIR-COOLED SYSTEMS FOR NEW HOSPITAL BUILDING.

AS REGARDS EXISTING HOSPITALS, HEALTH AUTHORITIES HAVE BEEN ASKED TO GIVE DETAILS ABOUT THE TYPE AND NUMBER OF WATER SPRAY SYSTEMS NOW IN USE, AS A FIRST STEP TO CARRYING OUT THE RECOMMENDATION THAT URGENT CONSIDERATION SHOULD BE GIVEN TO THEIR REPLACEMENT. ONLY A MINORITY OF HOSPITALS ARE THOUGHT TO HAVE SUCH SYSTEMS BUT THE ENQUIRY WILL ESTABLISH AN ACCURATE NATIONAL PICTURE. I UNDERSTAND THAT THE INQUIRY TEAM DID NOT ENVISAGE IMMEDIATE REPLACEMENT OF SUCH SYSTEMS; THEY WERE CONCERNED TO ENSURE THAT EXISTING SYSTEMS OPERATE AS SAFELY AS POSSIBLE AND THOSE WHICH HAVE REACHED THE END OF THEIR NATURAL LIFE OR PRESENT PARTICULAR MAINTENANCE PROBLEMS SHOULD HAVE PRIORITY FOR REPLACEMENT.

Mr Speaker, early action was taken with the two Health Authorities in July 1985 and January 1986 and further instructions, based upon this first report, have now been issued to Health Authorities. These steps will reduce the risk of any repetition of the outbreak. Production of a Code of Practice and setting up the register of engineers experienced in this field will also contribute to that end. In the longer term the new Committee on biocides should help to clarify how these chemicals can best be used to reduce risks further. Information is being collected about existing hospital water spray cooling systems as a first step in the consideration of their longer term future.

We owe a great deal to Sir John Badenoch and his fellow Inquiry members for the energy and application they have brought to producing Part 1 of their report. For the broader questions about what may need to be done to reduce any risk from the disease in other circumstances in hospitals, other buildings and elsewhere the Government looks forward to the second report which is expected around the turn of the year.

SCBG

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From The Parliamentary Under-Secretary

CT/5006/86

30 May 1986

Dear Mike,

LEGIONNAIRES' DISEASE: STAFFORD HOSPITAL INQUIRY

Thank you for your letter of 23 May covering the first part of the Stafford Hospital Inquiry's Report and the statement to the House which your Minister proposes to make.

Mr Robinson has seen both and is content for Mr Hayhoe to make the statement in the way he proposes. My Minister has already been briefed by officials as a consequence of the liaison they have had with those in DHSS responsible for the Inquiry.

I am copying this letter to David Stewart, Jim Daniel, Mark Addison, Rachel Lomax, Stephen Boyes Smith, John Mogg, Robin Young, Geoff Dart, Richard Allen and Richard Mottram.

Yours ever

Roy

R O'SULLIVAN
Private Secretary

M O'Connor Esq
Private Secretary to
Rt Hon Barney Hayhoe MP
Department of Health and Social Security
Alexander Fleming House
Elephant and Castle
LONDON
SE1 6BY

NAT HEALTH
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JS

CONFIDENTIAL

Prime Minister, (4)

For information. I have not attached the report itself, which is long.

MEA 27/5

cc PRESS OFFICE

cc Press Office.

DEPARTMENT OF HEALTH AND SOCIAL SECURITY
Alexander Fleming House, Elephant & Castle, London SE1 6BY
Telephone 01-407 5522

From the Minister for Health

R O'Sullivan Esq
Gwydyr House
Whitehall
SW1A 2ER

23 May 1986

Dear Rory

LEGIONNAIRES' DISEASE: STAFFORD HOSPITAL INQUIRY

Following the major outbreak of Legionnaires' Disease at Stafford District General Hospital in May 1985, in which 28 people died, the Secretary of State for Social Services set up a public inquiry chaired by Sir John Badenoch.

The inquiry divided its work into two parts. The first part - now concluded - was to investigate the cause of the Stafford outbreak and the measures taken to deal with it and to make such recommendations as then seem justified as regards hospital air conditioning systems. The second part is to consider and make recommendations on any action necessary to reduce the risks of future outbreaks whether originating in hospital, other buildings or elsewhere. This second part is about to start and will be held in private. A report is expected around the turn of the year.

The report of the first part, on the Stafford outbreak itself - has been received by my Secretary of State and he intends to publish it, most probably on Wednesday 4 June by way of an oral statement in the House. I enclose a copy of the report and of the statement my Minister intends to make. Copies of the report and a draft of the statement were made available to officials in your Department earlier. The statement now circulated is substantially the same.

The report's recommendations are all related either to local management matters or steps which might be taken to reduce the risk of similar outbreaks from wet spray cooling tower systems in other hospitals. Whilst such systems are found in other kinds of buildings utilising air conditioning the recommendations made are all specific to hospitals where there are concentrations of particularly vulnerable people. The action that Ministers will be announcing at this stage will accordingly relate to the recommendations so far received from the Inquiry. In response to any questions about the possible wider implications of the recommendations outside the hospital context in which they were made, my Minister

E.R.

intends to take the line that the Government looks forward to receiving the report of the second part of the Inquiry which is specifically concerned with the steps which may be necessary to reduce any danger in other buildings and situations. In the meantime he had drawn the attention of Ministerial colleagues to the report of the first part of the Inquiry and to the action being taken on it regarding hospitals. Our Department is also bringing the report to the attention of the Chartered Institution of Building Services Engineers and the Heating, Ventilating and Air Conditioning Contractors Association so that they can be aware of and can consider its possible implications. They will also be informed of the action taken in respect of NHS hospitals.

If you have any comments to make on the approach proposed it would be helpful to know before the end of next week.

I am copying this letter and the request for comments to David Stewart, Jim Daniel, Mark Addison, Rachel Lomax, Stephen Boyes Smith, John Mogg, Robin Young, Geoff Dart, Richard Allen and Richard Mottram. Home Office, Treasury and Defence will not have received a copy of the report earlier.

Yours sincerely

M. O'Connor

STATEMENT

With permission, Mr Speaker, I will make a statement about the first report of the Badenoch Committee of Inquiry into the Outbreak of Legionnaires' Disease in Stafford which we are publishing today, and on the action we propose to take in response.

The outbreak at Stafford District General Hospital occurred in April 1985. 101 patients caught the disease and there were 28 deaths. This made it the second most serious recorded anywhere, surpassed only by the major outbreak in Pennsylvania in 1976 from which the disease was first recognised. The source of infection was found to be the hospital itself, specifically the air-conditioning system serving the Outpatients' Department. My Rt Hon Friend the Secretary of State for Social Services appointed a statutory Public Inquiry on 7 June 1985, chaired by Sir John Badenoch.

The Inquiry has produced a first report, covering the Stafford outbreak itself and has made such recommendations about hospital air conditioning systems as seem appropriate at this stage. The Inquiry will now go on to consider ~~the~~ and make recommendations on any action necessary to reduce the possibility of future outbreaks whether in hospitals, other buildings or elsewhere and the Government expect to receive its second report around the turn of the year.

The report concludes that, on present knowledge, the outbreak at Stafford cannot be attributed to any single factor nor does it hold any individual or group directly responsible. It points out that Legionnaires' Disease has only recently been identified and we are at a very early stage in our understanding of it.

The report refers to a number of circumstances which, taken together, may have produced a situation in which this outbreak took place. These circumstances include defects in the design and construction of engineering services, problems during the commissioning of the air conditioning plant, lack of knowledge and understanding of the sophisticated engineering plant, and changes in the weather during the month in which infection occurred. The Report also points to the difficulty, on present knowledge, of eliminating the Legionella bacillus in complex hospital engineering services involving water spray cooling towers for air conditioning.

The report praises those concerned with patient care for the way in which cases were dealt with once the outbreak had begun. This was something to which the then Minister for Health paid tribute in his statement to the House on 7 May last year and which I am glad to have the opportunity to endorse. The report does however make a number of recommendations specific to the circumstances surrounding the outbreak and requiring local action. In particular it calls for a review of the health authority's microbiological services. The West Midlands RHA and the Mid-Staffordshire DHA are being asked to report within three months on the follow-up action they have taken or intend to take.

Other recommendations fall broadly into two groups. First are those concerned with action to reduce risk of build up of Legionella infection in ~~all those~~ existing air conditioning systems in hospitals which utilise water spray cooling arrangements.

The report specified particular design and construction problems with the air conditioning plant. Immediate steps are being taken to ask health authorities to check for similar problems and take appropriate action. This follows up guidance issued to health authorities earlier this year in the light of what had then been learnt from the Inquiry.

Action is being taken urgently on the recommendations that a Code of Practice for hospital engineers should be produced and that a register of engineers with relevant experience should be established so as to provide readily available expertise to the Communicable Disease Surveillance Centre and Health Authorities when needed. Discussions are already in hand with the Public Health Laboratory Service about the register.

The Inquiry recommended that a committee of experts should be convened urgently to consider all aspects of the use of biocides as a means of minimising build up of Legionella. I am glad to announce that the Committee will be chaired by Dr A E Wright, Director of the Public Health Laboratory Service's Newcastle Laboratory, and I hope it will be possible for it to begin its work shortly.

The action being taken urgently on these and related recommendations should help to reduce risks as far as possible within existing water spray cooling towers for air conditioning systems which must be our first priority.

The second group of recommendations were concerned to reduce hospitals' reliance on air conditioning in general and replacing water spray cooling towers in particular. These stem from the Inquiry's conclusions about the inherent difficulty of eliminating the risk of Legionella infection in hospital air conditioning systems when complex water spray cooling towers are used.

Current hospital building policy, with its emphasis on smaller hospitals, has meant for some time that new hospitals generally need less air conditioning. The risk of infection identified by the report will be taken into account along with other considerations in developing future design policy.

The report's recommendations that urgent consideration should be given to replacing existing water spray cooling towers and no new ones built will need to be considered seriously with NHS authorities and others concerned, so that their detailed implications can be properly assessed. This will be done urgently, but will not detract from action to ensure that existing systems operate as safely as possible as it is clear that whatever may be the right conclusion to reach about the future of these systems - found only in a minority of hospitals - they cannot be replaced overnight.

We owe a great deal to Sir John Badenoch who chaired this Inquiry and to the members of his team for the energy and application they have brought to their task. I wish to stress that this report will be taken very seriously both by my Department and by the National Health Service. For the broader questions about preventing the disease in other types of building and for the work which needs to be done to improve knowledge of its causes and incidence, the Government looks forward to the second part of the Inquiry's report.

Legionnaires Disease Inquiry
Room D006
Alexander Fleming House
Elephant and Castle
London SE1 6BY

Tel: 01 407 5522 Ext 6964

14 March 1986

Dear Secretary of State,

In submitting this report to you, my colleagues and I would like to draw your attention in particular to the number of persons involved in the outbreak. You will see that in paragraphs 110 and 111 the number of those affected is given as 101, of whom 28 died.

These numbers differ by one from those in the fourth report from the Communicable Disease Surveillance Centre (CDSC) given to us at the end of the public hearing. We are aware that considerable anxiety has been caused in Stafford as a result of the difficulty in establishing the exact size of the outbreak and by the fact that the figures given by CDSC in each successive report not only varied but differed from those given by the District Health Authority (DHA).

The reason for the difference in the figures given by the DHA and CDSC stemmed from the fact that those given by the DHA included all the patients admitted to hospitals with severe pneumonia during the period of the outbreak, while the figures from CDSC were based on criteria for the diagnosis of Legionnaires Disease agreed between the various laboratories concerned.

The final report from CDSC has not yet been published and further analysis of the data now available can still lead to minor changes in the figures but they will be substantially the same as those given in this report and we are confident that our Inquiry has established the essential parameters of the outbreak.

In writing to you we would like to take this opportunity to express our gratitude to our Secretary, Mr Edmund Waterhouse, for the tireless way in which he has supported and helped us, both during the public hearing in Stafford and during the production of this report. We are also grateful to Mrs Jane Robinson for her willing assistance at every stage of our work.

John Badenoch

SIR JOHN BADENOCH

CHAPTER 1: INTRODUCTION

Background

1. The District General Hospital in Stafford (the SDGH; see figure 1 opposite) which opened in 1983 was the first entirely new hospital to be built in the district for nearly a century, and the people of Stafford were proud of it.

2. Standing on a hill above the town and surrounded by lawns, the hospital offered up-to-date facilities for medical care in attractive surroundings. It inspired confidence among the local community and pride among those who planned, built and worked in it.

3. Suddenly in April 1985, within two years of the first patient being admitted, it became the setting for the worst outbreak of Legionnaires' Disease which has occurred in this country, and tragically the new hospital itself was shown to be the source of the infection.

Establishment Of Committee Of Inquiry

4. In an urgent response to public concern over the outbreak, felt not only in Stafford but nationally as well, on 7 May 1985 Mr Kenneth Clarke, then Minister of State for Health, announced that a Committee of Inquiry would be set up.

5. The Committee was given the following terms of reference:-

> to inquire into the cause of the recent outbreak of Legionnaires' Disease in Staffordshire;
>
> to consider the adequacy of measures taken to investigate and to deal with the outbreak; and
>
> to report to the Secretary of State for Social Services and make recommendations on any action necessary to reduce the danger of future outbreaks originating in hospitals, other buildings and elsewhere.

Recommending Further Research

6. We were formally appointed on 7 June 1985. One of our first tasks was to seek confirmation that it was within our terms of reference to make recommendations in our final report as to fields of further research. We received such confirmation on 26 June.

Our Inquiry

7. Our first decision was to divide our Inquiry into two parts. We would undertake to investigate with reasonable speed the cause of the Stafford outbreak and the adequacy of the measures taken to deal with it; we would report and make recommendations as then seemed justified. Having thus responded to the immediate public concern, we would inquire into the broader question and in a second report make recommendations on "any action necessary to reduce the danger of future outbreaks", wherever they might originate.

8. The nature of the first part of our Inquiry seemed to us to justify hearing evidence in public, in Stafford. For the second part, in the absence of a localised focus of public concern, we would hear expert evidence in private.

The Public Hearings In Stafford

9. We considered it our primary function to establish the facts about the outbreak and to make recommendations. We would not hesitate to criticise where appropriate, but we regarded the apportionment of blame to be outside our terms of reference. Therefore, in order to be fair to all parties, whenever evidence was submitted which made or appeared to make allegations against an individual or organisation, advance notice was given in writing to the individual or organisation by the Treasury Solicitor acting on our behalf. Furthermore, we sought to grant representation in time to allow for cross-examination and the calling of any additional evidence needed to explain or rebut the allegations.

10. In this as in other respects we were guided by the Report of the Royal Commission on Tribunals of Inquiry (the "Salmon Report") and in particular the principles set out in paragraph 32. In seeking to follow the

procedures for improving the safeguards for witnesses and interested parties (Chapter IV) we encountered difficulty in reconciling the demand for speedy conduct of this part of our Inquiry with the need to allow represented parties sufficient time to prepare their respective cases (cp paragraph 49 of the Salmon Report). In the event we believe that no injustice was done.

Conduct Of Inquiry

11. We began with a study of the medical aspects of the outbreak. We did this to give priority to the patients and their next-of-kin who were willing to give evidence in person and also because the engineers needed as much time as possible to prepare their statements.

12. Throughout the hearing of evidence, medical and engineering, we had the assistance of leading and junior counsel instructed by the Treasury Solicitors. We made grants of representation to various parties for such parts of the hearing as reflected their interest in the topics under consideration. A list of the parties and their representatives is at Appendix 1.

13. We held a Preliminary Hearing on 25 June 1985 and subsequently took evidence on 31 days between 9 July and 3 October inclusive. For the greater part of this period we sat in the Gatehouse Theatre, Stafford; for the last four days we sat in a specially converted ward at St George's Hospital, Stafford. In order to hear fresh factual evidence which came to light after 3 October we reconvened for two further days, on 7 and 8 January 1986, returning to St George's Hospital to do so. The public and the press were admitted to all such hearings.

14. We list at Appendix 2 the witnesses from whom we received evidence. Such evidence was principally oral and given on oath. Most of such oral evidence was adduced in chief by one of the counsel to the Committee and thereafter subjected to cross-examination by all parties. When a witness was represented, the counsel concerned occasionally examined in chief and invariably re-examined. The statements of certain witnesses whose evidence was wholly uncontroversial were read in public. We sought to limit all evidence to matters of fact, leaving expressions of opinions for those oral and written submissions that have been tendered to us (see Appendix 3).

15. To assist us in evaluating this formal evidence we visited the SDGH on several occasions, and the Microbiology Laboratory at St George's Hospital once. We also watched a video recording made by the engineers of the Mid-Staffordshire Health Authority, which we discuss later.

16. From the outset of the Inquiry it was apparent that neither medical nor engineering matters could be investigated without expert assistance for us and for our counsel. Indeed, if the parties, the press and the public were to understand many of the issues put before us, prior introductory explanation was needed. Accordingly we asked a number of independent experts to advise us and our counsel, and to give evidence. We list these experts at Appendix 4. At our request, our engineering experts investigated the relevant air conditioning plant and its operation.

17. Before the medical evidence began, our two medical experts Dr J Tobin and Dr J Macfarlane delivered background lectures illustrated by slides; the engineering evidence was similarly introduced by one of our engineering experts, Dr G Brundrett. We found that these lectures made an exceedingly effective contribution to the general understanding of the evidence then put before us, and we commend the adoption of this procedure for public inquiries similarly concerned with technical topics.

18. Once engineering experts had been engaged, certain experiments were devised with their aid in order to test various aspects of the functioning of the hospital's air conditioning systems. We list these experiments in Appendix 5, and refer in Chapters 10-12 to those results which have materially affected our conclusions.

19. Finally, we have supplemented the evidence we have received by reading a large number of learned articles and other literature. In fact this reading has proved more relevant to the second half of our Inquiry and accordingly will be listed as an Appendix to our final Report.

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CHAPTER 2: THE MEDICAL SERVICES AT STAFFORD

Organisation And Management

20. In England the National Health Service is divided into 14 Regional Health Authorities (RHAs), which are directed by the Secretary of State for Social Services to exercise certain specified functions on his behalf. The West Midlands RHA, one of the 14, is based at Birmingham and is responsible for health services in the counties of Hereford and Worcester, Shropshire, Staffordshire and Warwickshire as well as in the West Midlands metropolitan county. The RHA's functions which are relevant to our Inquiry are, first, the undertaking of major building works - it was the "client" for the building of the SDGH, in succession to the Birmingham Regional Health Board - and, second, the provision of specialist advice and services to District Health Authorities (DHAs).

21. The West Midlands RHA is subdivided into 22 DHAs. We are concerned only with one: the Mid-Staffordshire DHA (hereafter referred to as MSHA), which is based in Stafford and covers an area embracing the three local government districts of Cannock Chase, South Staffordshire and Stafford itself. The functions of DHAs are those formally delegated to them by RHAs on the direction of the Secretary of State; in essence each DHA is responsible for the day-to-day management of health services in its district.

22. At the time of the outbreak in April 1985 the management structure of MSHA was still developing in the light of the recommendations of the NHS Management Inquiry. Certain arrangements then in operation were temporary, but we have not been made aware of any consequent problem relevant to the Inquiry.

23. In February 1985 Mr J A Bartlett was appointed MSHA's General Manager, having previously been District Administrator. At the time of the outbreak he was assisted by a Management Advisory Team composed of representative senior District personnel, a consultant and a General Practitioner. Specific management functions were delegated to five Unit Management Teams (in due course to be replaced by Unit General Managers), each concerned with a particular aspect of the District's medical services. One such management team was solely concerned with the day-to-day management of the SDGH, subject to the overall direction of Mr Bartlett and his Management Advisory Team, and

consisted of Mr T L Storrow (the Unit Administrator), Mr C Wilkinson (Director of Nursing Services) and Dr N J Burbridge (Consultant Anaesthetist).

24. An important function of District is to provide a works service for its hospitals and other establishments. In MSHA this function is the responsibility of Mr C B Denne, the District Works Officer, who is assisted by the District Engineer, Mr E P Miles. Mr A Rutter is the Unit Engineer responsible for the SDGH, and he is assisted by Mr S C Dalton and Mr A J Henshall. Following handover in November 1982, operation and maintenance of the SDGH became the responsibility of Mr Rutter and of his District superiors Mr Miles and Mr Denne.

25. Since 1 April 1982 the District Medical Officer has been Dr J A Scully, who also holds the post of Medical Officer for Environmental Health. He has a variety of responsibilities, one of which he described as follows: "If there is a reported outbreak of a notifiable disease my duty is to set up the appropriate investigation and to arrange appropriate action and services, and the secondment of staff to assist". Dr Scully considered that the outbreak of Legionnaires' Disease, though not a notifiable disease as defined by statute, imposed on him the same duty.

The Hospitals In Stafford

26. For acute hospital services MSHA serves a population of nearly 200,000, including the town of Stafford which has a population of about 57,000. In a relatively confined area to the north of the town centre (see figure 2) lie four hospitals:

a. Stafford District General Hospital (SDGH), which has 323 beds and provides various facilities including an accident and emergency department, out-patient department (OPD), an intensive therapy unit, a coronary care unit, a maternity unit, an acute medical admitting ward, operating theatres and surgical wards. It serves the immediate locality, roughly within a radius of about 15 miles.

b. Staffordshire General Infirmary (SGI), which has 189 beds and has only partly been superseded by the SDGH. In particular it contains the main general medical wards for the District.

c. St George's Hospital, which is a psychiatric hospital with 541 beds. The District's Department of Microbiology is on the same site.

d. Kingsmead Hospital, which is a geriatric hospital with 84 beds.

The Physicians

27. For the four Consultant Physicians (Drs P R Daggett, A J Fairfax, H J L Francis and J A Gibson) who between them provide the general and specialist medical care at the SDGH and SGI this physical separation of medical services poses organisational problems, given that their general medical beds - a little over 100 in number - are at the SGI, while their acute admitting ward (24 beds) their intensive therapy unit (5 beds), their coronary care unit (5 beds) and their out-patient clinics are at the SDGH. To provide all their junior staff with experience of acute medical emergencies they have arranged that each junior doctor should spend six months at the SDGH and six months at the SGI. At the SDGH they work on the acute admitting ward on a daily duty rota, working for all the physicians in turn. Each consultant is responsible for emergency medical admissions for a 24-hour period (72 hours at weekends) at the end of which - that is to say, on the morning of the day following the period of duty - he conducts a ward round for the junior medical staff during which the patients who have just been admitted are reviewed.

28. Two Consultant Physicians in Geriatric Medicine, Dr S Paulose and Dr P S Grero, provide the medical care at Kingsmead. They are assisted by Dr S Iqbal. They operate their own separate rota in conjunction with their junior doctors. Each physician attends the SDGH for out-patient clinics.

The Department Of Microbiology

29. The microbiology laboratory for the District is housed in a single-storey detached building, described to us as "temporary", in the grounds of St George's, some three-quarters of a mile from the SDGH. On our visit there we found the building cramped, but reasonably well equipped to provide an acceptable level of microbiological services for the local hospitals.

30. Head of the Department is the MSHA's Consultant Microbiologist, Dr E Nnochiri. He has a medical registrar, at the relevant time Dr L Solaro. The Department has a laboratory staff of 12 headed by Mr I L McCartney, Senior Chief Medical Laboratory Scientific Officer (MLSO), and Mr M G Holliday, Chief MLSO.

31. It is not within the capacity of the laboratory - and we would not expect it to be otherwise - to conduct the specialised virological testing appropriate for identifying influenza, nor the specialised serological testing for Legionella pneumophila. For such purposes samples are sent as a matter of routine to reference laboratories, principally the Public Health Laboratory, East Birmingham Hospital. Where such testing is requested by a clinician, it is the function of the Department of Microbiology to forward the samples to the reference laboratory, and on receipt of the report to convey the findings to the clinician.

Relations Between The Department Of Microbiology And The Clinicians

32. We preface our history of the outbreak (chapter 4) with some detailed but necessary discussion of the relationship between the Department of Microbiology and the rest of the hospital services in Stafford.

33. The Department is relatively isolated from both the SDGH and the SGI. Factors other than geography contribute to its separation from those hospitals. First, Dr Nnochiri divides his time between MSHA, where he works routinely on Mondays, Wednesdays and Fridays, and SE Staffordshire Health Authority where as the Consultant Microbiologist for that District he attends Burton-on-Trent Hospital every Tuesday and Thursday.

34. Second, Dr Nnochiri's reserved personality does not facilitate the use of his time in Stafford to establish good working relationships with the clinical staff (nor for that matter with the staff in his own department). Soon after taking up his post at Stafford in 1974 an unsolicited attempt by him to advise on a patient's antibiotic regime had resulted in a serious disagreement with a consultant surgeon (now retired); and thereafter the initiative for any liaison between the clinicians and

Dr Nnochiri has had to come from them, although we were told Dr Nnochiri responded helpfully to such requests. Dr Nnochiri himself stated that the comparable relationship at Burton, where the microbiology laboratory was close to the wards, was "a great deal easier". When asked about his regular involvement with the clinicians at Stafford, he gave a revealing answer: "there is a consultants' committee meeting which I used to attend but in the last four or five years it has tended to clash with a similar meeting at Burton-on-Trent and I have naturally tended to attend the Burton-on-Trent meeting". Again, from the evidence put before us we have concluded that Dr Nnochiri's relationship with his microbiological staff in Stafford is as remote as with the clinicians, and to a marked extent the microbiology department there seems to have functioned without leadership from him.

35. Third, by the time the Legionnaires' Disease outbreak started, contact between any of the staff of the microbiology laboratory and the clinicians at the SDGH was minimal. Dr Nnochiri told us that he sought to maintain a microbiology presence on the wards through his registrar. He said that such had been achieved with an earlier registrar, but not with Dr Solaro. Dr Solaro did not really dispute that statement, but made it clear that he disagreed with Dr Nnochiri over the cause of the problem. We directed ourselves that we need only note the resulting state of affairs, the background dispute being outside our terms of reference.

36. Furthermore, from 31 March 1985 a useful source of liaison between the hospital and the microbiology laboratory ceased. Up to that date Mrs M A Hodgson, an MLSO in the department, had worked for about 18.5 hours a week at the SDGH as Control of Infection Technician. As discussed below, this post was then terminated.

Control Of Infection

37. The Consultant responsible for control of hospital infection was Dr Nnochiri. As such he was Chairman of the Control of Infection Committee (CIC). This Committee, of which Dr Scully was a member, was composed of medical, nursing and administrative representatives. It normally met about three times a year to formulate advice on countering hazards. In the event of an outbreak of infection occurring, it would meet as required with a membership enlarged on an ad hoc basis to advise on the measures to be taken to counter the outbreak. Dr Scully claimed a responsibility for ensuring that such advice was implemented.

38. The termination of the post of Control of Infection Technician from 31 March 1985 followed prolonged debate which had centred on two issues: first, whether the expense attendant on the post could be justified; and second, whether the post should be funded from the microbiology budget (so as to result in the appointment of a technician) or from the nursing budget (so as to result in the appointment of a nurse). The outcome of the debate was the appointment of Mrs Hodgson (as a technician funded from the microbiology budget) initially for the year ending 13 June 1984, and then for the further and final period to 31 March 1985. Throughout Dr Nnochiri played a positive role, promoting the original appointment and protesting against its termination.

Public Health Laboratory Service: Communicable Disease Surveillance Centre (CDSC)

39. Following a recommendation made in the Report of the Committee of Inquiry into the Smallpox Outbreaks in London in March and April 1973 (the report of the "Cox Committee") the Communicable Disease Surveillance Centre (CDSC) was established in 1977 by the Public Health Laboratory Service (PHLS) on behalf of the DHSS and the Welsh Office. The main functions of the Centre were specified in February 1980 in a DHSS Health Circular, HC (80)2, which stated that CDSC "responds to requests for advice, in collaboration with PHLS and hospital laboratories, co-ordinates control measures in an outbreak involving a number of districts, and is able to give assistance to MOsEH particularly in serious incidents." The circular also drew attention to its epidemiological function. An article (Community Medicine, 1980; 2, 135) by Dr N S Galbraith and Dr Susan Young, respectively Director and Deputy Director of the Centre, provides a more comprehensive account of its development and activities, specifying inter alia its concern since its inception with reported outbreaks of Legionnaires' Disease.

40. CDSC has four full-time and one part-time consultant medical epidemiologists and six other medical staff, together with statisticians and other ancillary staff. For two years from September 1982 Mr D Harper, an engineering scientist employed at Kingston Hospital by Kingston and Esher District Health Authority, was seconded to the Centre to provide engineering expertise. When his secondment terminated he was not replaced; but he retained a personal loyalty to CDSC so that he remained willing to advise when requested.

CHAPTER 3: MEDICAL BACKGROUND

Origin Of Legionnaires' Disease

41. The name "Legionnaires' Disease" was coined to describe an outbreak of severe pneumonia among American ex-servicemen attending a reunion of the American Legion in a Philadelphia hotel in 1976. 182 people contracted the disease, of whom 29 died. 38 people who passed close to the hotel contracted a similar illness (called "Broad Street pneumonia"), and 5 of them died. Conventional tests failed to discover the cause of the pneumonia, but, after several months, sustained investigation in the microbiology laboratory revealed an unusual organism which proved to be the cause of infection. The organism was called "Legionella pneumophila", after the disease. Soon afterwards the development of a technique to measure antibodies to Legionella in the blood led to the retrospective assessment of a number of isolated cases and unexplained outbreaks of pneumonia which had occurred previously. The organism was also shown to have caused a number of subsequent outbreaks in hotels, hospitals and other institutions as well as sporadic, isolated cases in the community.

42. Legionella pneumophila is a slender motile bacillus which fails to grow on the artificial media customarily used in the diagnostic bacteriology laboratory. Therefore special media have been developed which meet the organism's unusual nutritional requirements. Such media can be used to demonstrate the presence of Legionella in materials from patients (such as blood or sputum) and to assess the number of organisms present in environmental samples, particularly water. Despite the use of the special media, it is possible for Legionella to be present in some samples but fail to grow in the laboratory.

43. Another method used for samples from both patients and the environment is to show that bacteria visible under the microscope possess surface components characteristic of Legionella. This can be done by means of antibodies which attach only to Legionella and not to other bacteria and can therefore serve to identify it. By coupling a fluorescent dye to the antibody, its attachment to the bacterium can be made visible under the microscope. Recently it has become possible to identify individual surface components by means of monoclonal antibodies, and this has facilitated the recognition of separate species, of which there are currently at least 23, and within species separate types. In environmental samples from which the

organism cannot be cultivated it may still be possible to demonstrate its presence by showing that certain fatty acids are present in a ratio characteristic of Legionella; but if other kinds of bacteria are also present this result will be confounded.

44. Patients infected with the bacillus typically develop antibodies in their blood as part of the body's defence mechanism. Such antibodies can be demonstrated by reacting the patient's serum with Legionella pneumophila in the laboratory in such tests as the immuno-florescent antibody test (IFAT) and the rapid micro-agglutination test (RMAT).

45. Knowledge of the organism, which has developed from studies of the various outbreaks as well as from laboratory research, nevertheless remains incomplete. Legionella is now known to be widely distributed in nature where it can be found in all aquatic habitats, predominantly in surface waters and preferably where the water is warm, and is often associated with algae and organisms such as amoebae on which it may depend for nutrients. It can become airborne in small droplets of water and by that means may colonise other environments.

46. The organism may flourish not only in natural habitats such as ponds rivers and lakes - even the volcanic lakes newly created after the Mount St Helens eruption in the USA - but also in artificial environments including domestic water tanks and supply pipes, and the tanks, cooling tower ponds and pipework of air conditioning systems: in short, wherever there is water. It has a preference for habitats where the water temperature is between 36°C and 60°C. In hot water systems it survives comfortably in water stored at temperatures between 20°C and 45°C. It is not eliminated from a hot water system by raising the temperature to 60°C, but is seldom isolated from water below 15°C. It has been shown to survive as long as 400 days in tap water. Surveys have shown it to be present in hotel and hospital water systems.

Incidence Of Legionnaires' Disease

47. The Legionella organism is commonly found in water systems within buildings, including hospitals, and because exposure to it is potentially preventable there is understandable, indeed justifiable, public concern over any outbreak or risk of an outbreak. Nevertheless, Legionnaires' Disease appears to be relatively uncommon. There are thought to be between 100 and 200 cases each year in the United Kingdom. In Europe overall Legionnaires' Disease is thought to account for 2-10 per cent of all cases of pneumonia.

Conditions For Human Infection

48. The organism is ubiquitous and may occur wherever there is water. Before it can become dangerous for man it must be able to multiply to a potentially dangerous concentration; it has to be transmitted through the air in such a way that it can be inhaled into the depths of the lungs; the strain of the organism has to be capable of causing human infection; and finally the lungs of the person inhaling it must be incapable of combatting the infection.

Multiplication

49. Given the presence of Legionella in the environment, the precise factors which enable the organisms to multiply to the concentration associated with outbreaks of disease are still not known. Multiplication is favoured by inadequate drainage and replenishment of water, an appropriate temperature, and possibly by the presence of iron salts and organic matter; and by the presence of long pipe runs, dead ends and blind loops in water distribution systems.

50. Within water systems in buildings the multiplication of Legionella may be inhibited by certain additives which may be introduced for a variety of purposes. One such is the chlorine that is used routinely as a bacteriocide in mains water supplies. Again, there are the chemicals (biocides) which are used to treat the water circulating in cooling systems to prevent the build up of scale, the growth of algae and other micro-organisms. These biocides can discourage the multiplication of Legionella in water systems; laboratory tests have shown that if present in sufficient concentration they can kill the organism itself, although their capacity to do so under field conditions cannot necessarily be relied upon.

Dissemination

51. Respiratory infections may be contracted by inhalation of organisms carried in the air, and the evidence is overwhelmingly in favour of infection with Legionella pneumophila being transmitted in this way: there is no evidence that infection may arise from drinking contaminated water. The organism is carried through the air in minute droplets of water which evaporate leaving the organism suspended in the air. Airborne water droplets of this nature are described as an aerosol. The size of the droplet is crucial, for larger dust particles and droplets fall to the ground and cannot be inhaled: others are filtered out by the upper respiratory tract and do not reach the lungs. The depths of the lungs are penetrated only by organisms left suspended in the air once the carrier droplet has evaporated.

52. Two of the ways in which such dissemination is known to occur are, first, via shower heads or spray taps (which are used intermittently, and where the organism may multiply if the water is warm) and second via the plume generated by cooling towers: water is lost from such systems largely as vapour, but also partly as small droplets (aerosols). The droplets may be carried considerable distances in suitable weather conditions and can enter the air conditioning and ventilation systems of buildings. Experiments have shown that substantial numbers of Legionella organisms can survive "aerosolisation" in this way and produce pulmonary infection.

Susceptibility To Infection

53. All species of Legionella are a potential cause of legionellosis, but most human infections are caused by serogroups 1-4. Usually the organism is able to establish itself only when the defences of the lungs are impaired. The disease occurs chiefly in the elderly and in persons already suffering from chronic illnesses. Patients receiving immuno-suppressive therapy have a much reduced capacity to resist the infection and are particularly vulnerable to the disease. More men than women are affected, in the ratio about 3:1, one possible reason being that more men than women smoke.

Legionnaires' Disease: Symptoms

54. Often the sporadic cases which occur in the community are shown to have had recent contact with a hospital. The first symptoms of the disease usually occur between 2 and 10 days after exposure to the organism, though only in about 20 per cent of cases do patients have classical symptoms of pneumonia. There may be a sudden onset of malaise, profuse sweating and pain in the muscles, chills, headache and loss of appetite. In 50 per cent of cases there may be loss of memory, confusion, stupor, visual and auditory hallucinations, and sometimes a retrograde loss of memory lasting several days. Less common central nervous manifestations include an acute cerebellar disturbance which may persist, epileptic fits, isolated cranial nerve palsies and progressive peripheral neuropathy. A cough, initially dry and sometimes painful, may develop after the first few days and later sputum may be produced. Ninety per cent of patients have an abnormal chest X-ray even in the absence of chest symptoms. Changes in the X-ray progress in spite of treatment, and are slow to resolve. One patient in five suffers respiratory failure sufficiently severe to require mechanical ventilation.

55. Gastro-intestinal symptoms are common, one patient in two having diarrhoea, one in three nausea and vomiting, and one in five abdominal pain. The kidneys may also be affected, with one patient in eight developing renal failure. Abnormal results may be found when tests of liver function are carried out though the patients have no overt liver disease.

56. Legionellosis is also recognised in a separate, non-pneumonic, clinical syndrome known as Pontiac Fever (after the town where it was first found), which occurs as a short "flu-like" self-limiting illness with a high attack rate and affecting all ages - not just the elderly.

Diagnosis

57. The clinical symptoms can suggest influenza, or even gastro-intestinal disease. Chest X-rays will reveal consolidation which may progress, but there are no clinical or radiological features that are absolutely diagnostic of Legionnnaires' Disease. Improved methods have increased the frequency with which Legionella can be cultivated from respiratory secretions, but generally the specific diagnosis has been made by the

microscopic detection of the organism in sputum or washings from the bronchial tree, or by the demonstration of antibodies to the disease in the patient's serum. Unfortunately antibodies do not appear until after the first week of the illness, and even then the quantity may be insufficient to establish the diagnosis, so time - often critical - may be lost before clinicians know what disease they are treating. Tests such as the rapid micro-agglutination test which allow the disease to be diagnosed much earlier can now be performed and may when fully evaluated prove to be most useful.

Treatment

58. Because the treatment of the patient cannot be delayed until the diagnosis has been made, clinicians begin treatment with broad spectrum antibiotics. If a diagnosis of Legionnaires' Disease is suspected erythromycin should be given intravenously in large doses combined in serious cases with rifampicin by mouth. These two antibiotics are generally agreed to be the most effective in treating Legionnaires' Disease, although this has never been established scientifically in a controlled clinical trial.

Mortality, Prognosis And Sequelae

59. The vast majority of patients suffering from Legionnaires' Disease recover completely even if in some cases progress is slow. The mortality rate varies from epidemic to epidemic, but a review of the first thousand sporadic cases in the United States showed the overall mortality to be 19 per cent, being higher in those who were elderly, had significant underlying disease or renal failure, or whose natural immunity was in some way compromised.

CHAPTER 4: THE OUTBREAK FROM THE PATIENTS' AND DOCTORS' VIEWPOINT

Introduction

60. In this Chapter we describe the story of the outbreak of Legionnaires' Disease at the SDGH as it presented itself at the time to the patients, physicians and other hospital staff. We comment on it in Chapter 6. In assessing the extent to which we consider the action and judgements of the individuals concerned to have been reasonable in the circumstances we have sought to avoid hindsight and to exclude our knowledge of the eventual diagnosis.

61. We start with the first isolation of Legionella pneumophila in the SDGH because during the response to the outbreak in April and May 1985 it was considered to be an important part of the background (see paragraph 104 below).

The First Isolation

62. On 12 November 1984, as part of the SDGH's water treatment regime which we describe and consider in detail in Chapter 9, samples of water were taken from the ponds of all four of the hospital's cooling tower water systemsand tested for the presence of Legionella pneumophila. On 17 January 1985 Mr Rutter, the Unit Engineer at the SDGH, was informed by Mr Patrick Pickering, the representative of Fospur Limited (the water treatment Company), that the sample taken from the pond of cylinder 4's cooling tower water system had proved to contain this organism. Mr Rutter passed this information to Mr Miles, the District Engineer, and with the agreement of the RHA's water treatment specalist Mr Cripps he instituted measures aimed at chlorinating the cooling tower's water system to the level of 50 parts per million (ppm); he then had the system drained, cleaned and rechlorinated before bringing it back into service. Mr Rutter told us he was conscious that this cooling tower had been in continuous operation during the preceding eighteen months without having been stripped down for thorough cleaning and maintenance. It served the operating theatres and other specialist areas (including the special care baby unit and intensive therapy unit), and as a result he had never succeeded in persuading his hospital colleagues to agree that air conditioning of those areas should be suspended for the necessary maintenance period.

63. Once notified by Mr Rutter, Mr Miles informed Dr Scully (the MOEH) that Legionella had been found in cylinder 4's cooling tower water systems, and on 22 January he handed him a copy of the written report on the test of the water sample. In the knowledge of the remedial action taken by Mr Rutter, Dr Scully said that further samples should be taken for testing and that Dr Nnochiri, the consultant responsible for the control of hospital infection, should also be informed. Subsequently Mr Rutter spoke to Mrs Hodgson, the Control of Infection Technician, informing her of the finding, and through her he arranged to meet Dr Nnochiri on 30 January.

64. There was a conflict in the evidence about what took place at this meeting on 30 January. Mr Rutter said that he told Dr Nnochiri about the finding of Legionella pneumophila in the water sample and that he described the remedial action that had been taken. Dr Nnochiri denied that there had been any mention of the finding; indeed he claimed not to have been aware of it before the meeting with the engineers on 1 May 1985 during the second week of the outbreak (see Chapter 10, paragraph 204). For our part, the whole of the evidence readily satisfied us that Mr Rutter's account was to be preferred: the essential purpose of the meeting was to impart information about the finding to Dr Nnochiri, as advised by Dr Scully, and we cannot conceive of a failure on the part of Mr Rutter to do so, not least because it is common ground that Mr Rutter did put to Dr Nnochiri his proposals for a revised programme for the treatment and cleaning of all four cooling tower water systems (which would repeat every year the remedial action just taken). Indeed Mr Rutter confirmed this programme in a letter of 1 February to Dr Nnochiri. Unhappily this programme did not provide for twice yearly cleaning as specified by HN(80)39 (Appendix 5), and it appears that the fact that the agreed programme of maintenance did not in this respect comply with the official guidance laid down by DHSS was not appreciated by either Mr Rutter or Dr Nnochiri (whose failure to respond to the letter presumably reflected his approval of its proposals). We comment on this aspect of the history in Chapter 12.

65. Further samples were taken from the pond of the cylinder 4 cooling tower on 28 January 1985, which on 5 March were reported not to contain Legionella. Dr Scully recollected hearing the result of the retest; but no mention of it or of the earlier finding were made at the routine Control of Infection Committee (CIC) meeting held on 13 March at which Dr Scully, Dr Nnochiri and Mrs Hodgson were all present.

66. At the time no action was taken to establish the serogroup of the Legionella organism, but in June 1985 some time after the outbreak preliminary tests on the sample conducted by the Centre for Applied Microbiology and Research (CAMR) suggested that it belonged to serogroup Pontiac 2a. On 21 June Dr Lee of CAMR reported this provisional finding to a meeting between representatives of MSHA, CDSC and PHLS. This finding remained unaltered until near the end of the public hearing. Then Dr Lee of CAMR stated in evidence that the serogroup had been finally identified as Pontiac 1a, the same strain as that which caused the outbreak.

The Patients' Story

67. In 1985 Easter Sunday fell on 7 April. Out-patient clinics, normally held Mondays to Fridays, were not held over the long weekend but were resumed on Tuesday 9 April, an average of over 400 out-patients attending daily. As became known later, those out-patients who attended clinics - particularly medical, surgical and antenatal clinics - during the fortnight following Easter were unwittingly exposed to an aerosol containing virulent Legionella pneumophila. Some out-patients were relatively young and fit, others were elderly; these latter, especially males and particularly those who were smokers or who were already suffering from some debilitating condition, were vulnerable to infection. Many of them contracted a serious disease, manifesting as pneumonia, which proved fatal despite devoted care and nursing, and the administration of antibiotics.

68. It was inevitable that the evidence we received in public from patients was unrepresentative of the impact of the outbreak as inferred from the epidemiology discussed in the next Chapter. We could only hear first hand from those who survived, persons who were likely to be well below the average age of affected patients. Nevertheless their vivid accounts, supplemented by the evidence of the next-of-kin of those who died, served to bring home to us the powerful impact of this disease, its sudden onset, its effect upon body and mind, its threat to life and its sequelae, often continuing.

69. The account of one of the younger patients, that of Mr R C Pattison then aged 36, is an example. On Monday 15 April he accompanied his wife to the gynaecological clinic in the Out-Patients Department. In all they were in the hospital for only twenty five minutes. On 20 April, five days

later, Mr Pattison became ill with a high temperature and loss of co-ordination. On 26 April his continued deterioration led to his admission to the SDGH. His own memory for events then stops: he subsequently learnt from his wife that following admission he was delirious for long periods; that on 28 April he was transferred to the Intensive Therapy Unit where his breathing was supported by a ventilator for six days; and that there came a stage at which the Last Rites were administered. Thereafter he started to recover and was able to leave the hospital on 11 May. He had been treated with erythromycin and other antibiotics. At the time of his discharge his weight had dropped markedly; and when he gave evidence on 11 July he was still complaining of breathlessness when mounting stairs or an incline. Tests for antibody in his blood, during his illness and subsequently, proved strongly positive for Legionella. The severity of his illness was highlighted because previously he had been fit and vigorous, unlike so many of the other patients in whom a complicating illness contributed to and obscured the significance of the signs and symptoms.

70. Exposure to the organism for only a brief period could be followed rapidly by the onset of symptoms. Mr Pattison was in the Out-Patient Department for only twenty five minutes. Another victim, Mr Rowley, waited for a short time in a first floor corridor not served by Cylinder 4 but close to an open window opening onto an internal courtyard which might have been contaminated by "plume" (see Chapter 11).

71. For many patients the loss of memory, mental confusion, impaired co-ordination and double vision were the most frightening symptoms. The relatives of the late Mr Collier, previously a vigorous retired headmaster of 67 years of age, were so concerned that they actually showed the doctors a recent photograph of him lest his predicament might be attributed to senile dementia.

72. The patients and their families were unanimous in their praise for the dedicated care received from the nursing and medical staff. However, serious criticisms were raised by them about the lack of information imparted as to diagnosis and prognosis. Convalescing patients claimed to learn of the outbreak from the media; positive serological results were imparted haphazardly and often not at all; the implications of such results, whether short-term or long-term, were not explained; and next-of-

kin were inevitably perturbed by the absence of reference to Legionnaires' Disease upon the death certificates. In the event these problems were exacerbated by well-intentioned assurances given on 6 June by Mr Bartlett, MSHA's District General Manager, to a public meeting of patients, relatives and other interested persons, that information would be provided about the various matters causing concern. Mr Bartlett did not then have this information, which could only be obtained through the co-ordinated co-operation of the physicians, possibly after some delay whilst serological test results were obtained. In the event such co-ordinated co-operation was not forthcoming until the public hearing (see paragraph 75 below) and Mr Bartlett's resultant failure to honour his assurances, set in the context of an outbreak in an MSHA hospital, served to fuel public suspicion and frustration so as to reflect unfairly on Mr Bartlett.

73. The interest of the general public in the outbreak caused Mr Bartlett to issue regular press statements which contained information about the number of patients admitted to hospital during the outbreak and the number of deaths. The first statement mentioned 60 admissions and 11 deaths; the numbers progressed to 163 admissions and 39 deaths. Those figures were jointly produced by Dr Scully and the physicians, the basic criterion for inclusion being "a clear and definite assumption of a viral pneumonia".

74. Simultaneously the CDSC team were making their own epidemiological survey of the outbreak, examining patients' records and test results in the light of their own independently devised criteria. By the opening of our public hearings the CDSC's third report dated 25 June referred to 163 admissions and 46 deaths. We are now satisfied that the discrepancy reflected the use of differing criteria; but while it persisted, relations between the Health Authority and the public were harmed. We discuss this matter in detail in Chapter 5.

75. There were further strong indications of the poor state of public relations when patients and next-of-kin gave evidence. Whilst giving their evidence, certain witnesses were provided for the first time with the results of any relevant serological tests, together with a commentary as to the significance in terms of diagnosis. The test results were imparted by Mr Spencer (Counsel for the doctors); the commentary had to be tendered by our medical members. Thus it was that witnesses learned for the first time whether or not they or their next-of-kin had suffered from Legionnaires'

Disease. Again, at an early stage of the public hearing Mr Walmsley (Counsel for the patients) drew forceful attention to the lack of any schedule that served, however provisionally, to identify the persons believed to have been affected by the outbreak. We shared his concern and said as much. In the result and after much hard work on the part of a team led by Dr Scully in collaboration with CDSC, such a schedule was produced for us before the end of the public hearing. The schedule gave dimensions to the outbreak, served to provide a basis for reconciling the numerical discrepancy referred to in paragraph 74 above, and contributed to the epidemiology discussed in Chapter 5.

76. At a later stage of the hearing, Mr Walmsley similarly drew attention to the concern of some of his clients about the prognosis for those who had contracted the disease. Accordingly we asked Dr J Macfarlane to return and give evidence on this topic; he was able to reassure the patients that it was likely the majority would recover fully in time.

77. The fact that information about the outbreak in general, and about the diagnosis of individual patients in particular, came to be imparted in the course of the hearing was unsatisfactory but did not reflect upon those participating in the hearing. The essential problem was the earlier inadequacy of communication between the Health Authority and patients and next-of-kin. This inadequacy was partly attributable to the genuine difficulties inherent in collating and evaluating serological test results and clinical assessments; and partly to the failure of the medical staff to appreciate and respond to the continuing concerns of those involved in an outbreak of an emotively named, little understood disease.

The Clinicians

78. On Monday 22 April the Consultant 'on take' at the SDGH was Dr Francis. During his first ward round on that day he noticed that the situation was unusual. No less than 12 cases of pneumonia had been admitted over the preceding weekend, double the normal winter intake. Two of the patients (one relatively young) had already died and a number were severely ill.

79. The clinicians' immediate concern was to identify the cause of the illness and to begin effective treatment as soon as possible. At first the most likely diagnosis appeared to be severe pneumonia, secondary to influenza, although Legionnaires' Disease was considered among other less common causes.

80. Dr K A Rashed, the Medical Registrar on duty, had seen patients with Legionnaires' Disease before. He put it high on his list of possible diagnoses, but in the absence of an identifiable common source for the infection other possibilities were considered more likely. Prior to the ward round on the Monday morning he had sent off blood samples for testing for antibody to the disease. The arrival of these specimens during the morning was the first indication to the staff of the Department of Microbiology that something unusual was happening.

81. For Dr Fairfax, the physician next on take, the situation had become serious: 16 further admissions with pneumonia during his 24 hours. Being a specialist in chest medicine, his pursuit of a diagnosis was aggressive. He received little assistance from the patients' histories and examinations, and so he sought microbiological help.

82. At first he tried to persuade the Department of Microbiology to send a technician to the ward to help in taking samples for testing, but was told by Mr McCartney, the Chief MLSO in the Microbiology Laboratory and on duty in Dr Nnochiri's absence, that nobody could be spared; the task was one for the Control of Infection Technician, a post which had been discontinued a month previously. Dr Rashed then tried to contact Dr Solaro, the registrar in the Microbiology Department, but was told he was on holiday. Finally Dr Fairfax established direct contact with Dr T H Flewett of the Regional Virus Laboratory, East Birmingham, to secure advice on the taking of samples.

83. Dr Fairfax's search for the diagnosis and appropriate treatment led him to invite Dr Nnochiri to visit the ward. This Dr Nnochiri did, spending nearly an hour on the ward accompanied by Dr Rashed; he suggested that influenza B was the most likely diagnosis. There was disagreement in evidence over the date when Dr Nnochiri attended; since we are satisfied that there was no undue delay on his part, we did not seek to resolve the issue.

84. On Wednesday 24 April Dr Fairfax arranged to send the samples direct to Dr Flewett's Laboratory, thus bypassing MSHA's own Microbiological Laboratory. When Mr McCartney found out, to avoid confusion and duplication he sought to correlate his records with those of Birmingham Public Health Laboratory. After visiting the ward Dr Nnochiri went to the Microbiology Department at St George's and told Mr McCartney to send the patients' sera to Manchester Public Health Laboratory. This decision surprised Mr McCartney because it was usual to send specimens to Birmingham; he remembered having to look up the address of the Manchester Laboratory.

85. Even at this stage when the outbreak was increasing in severity such was the isolation of the Microbiology Laboratory at St George's that there was no sense of urgency about what needed to be done and the specimens were sent off that evening by post to Manchester in the routine way.

86. The rapid rise in admissions with pneumonia and the increasing number of patients with respiratory failure requiring ventilation inevitably posed management problems which were dealt with most efficiently and flexibly by the SDGH Unit Management Team. They held daily meetings and as early as Tuesday 23 April they started to increase the number of intensive care beds, ultimately making an extra 9 available. They arranged for one ward, subsequently enlarged, to deal exclusively with the patients with pneumonia. They limited other in-patient admissions to emergencies and urgent cases only. They increased the number of staff on duty at night and brought into use every available ventilator.

87. The efficacy of these arrangements reflects well not only upon the Unit Management Team itself but also upon the consultants, the junior medical staff (including those from the SGI who came over to the SDGH when off duty to see if they could help), nurses, and technicians and ancillary staff who tirelessly provided a standard of patient care which won warm public acknowledgement in the course of our Inquiry. Mr Bartlett, the District General Manager, assisted the hard-pressed Unit Management Team by deciding that all requests for information from the press and media should be handled not by the Team but at District level.

88. By Thursday 25 April the growing number of patients and the absence of a working diagnosis were causing the clinicians increasing concern and frustration. Dr Daggett's period 'on take' led him to telephone Dr P P Mortimer (a Consultant Microbiologist at the Virus Reference Laboratory, Colindale, London), Dr M B McEvoy (of CDSC) and Dr Scully. Subsequently, after discussion with Dr Daggett, Dr Francis prevailed upon Dr Nnochiri (as its Chairman) to convene an urgent special meeting of the CIC the following day. Through Mr Bartlett Dr Francis sought to ensure that all those involved should attend; regrettably the geriatricians at Kingsmead, which like the SGI had a quota of affected patients, were not invited to the meeting.

89. On the same Thursday one of the secretaries in the Microbiology Laboratory at St George's telephoned the laboratory at Manchester to find out whether the specimens sent by post the previous day had arrived. She found that they had not, and after discussion with the staff at Manchester it was decided to send a further batch by taxi. The missing specimens had in fact been delivered to the wrong laboratory but they were soon discovered. Both batches were tested that afternoon.

90. On Friday morning 26 April Dr Francis conducted a full round of the admissions ward at the SDGH and observed that 23 out of the 24 patients were suffering from pneumonia. He told us: "it had a very emotional impact ... I was really shaken by it".

91. On the same day Friday 26 April at 11.30 am a special meeting of the CIC was held, chaired by Dr Nnochiri. At the meeting Dr Francis described how serious the position had become. Up to that time 50 patients had been admitted with a severe respiratory infection, 6 had died and 13 were critically ill, 5 of them on respirators.

92. Dr Scully who was present told the Committee that he had learnt from the local general practitioners that there was a "flu-like" illness in the community but the distribution was patchy and certainly there was no major epidemic.

93. The possibility that influenza might be the cause of the outbreak recieved support from the fact that during the meeting Dr Fairfax received a telephone message from Dr Flewett to say that sera from two of the patients with pneumonia had been shown to have high titres to influenza B. In the light of this information it was decided that the best antibiotic regime to use was benzyl-penicillin combined with gentamicin, with erythromycin for those able to receive it orally. Many of the patients were elderly and had renal dysfunction, and concern about the possible dangers of fluid overload led to the exclusion of intravenous erythromycin at this stage.

94. Mr McCartney had attended the meeting. Despite the purpose for which it had been called, and despite the information presented at it by Dr Francis, no sense of urgency was conveyed to him (or at least so it appeared to us from his evidence). As a result, no special arrangements were made for the staff of the laboratory to work over the weekend and no further specimens were sent to Manchester until Monday 29 April. Even then they were sent by routine post and did not in fact arrive in Manchester until Thursday 2 May. In fairness we should add that a working diagnosis of influenzal pneumonia could reasonably have diminished the urgency with which the results of further diagnostic tests were required.

95. On Friday afternoon 26 April after the meeting Dr Scully telephoned Dr Gray at the PHL in Stoke on Trent to find out whether there was a similar outbreak of "influenza" in North Staffordshire. Dr Gray replied that although respiratory infections were prevalent and one patient had been identified as suffering from Legionnaires' Disease nothing out of the ordinary had occurred.

96. Dr Scully also telephoned Dr Young, Deputy Director of CDSC, to ask about the general prevalence of influenza in the country as a whole. They discussed the likely cause of the outbreak in Stafford and as it seemed to be influenza Dr Scully did not think that he needed to involve CDSC further.

97. Before Friday 26 April ended the emphasis had shifted again. That same evening Dr Fairfax received a telephone call from Dr Craske of Manchester PHL to say that two of the sera received the previous day had proved positive for Legionella pneumophila. He was unable to be certain whether the results were indicative of a recent or a past infection and the two specimens had been sent on to the PHL at Preston for further analysis.

98. On Monday 29 April Dr Macaulay of Manchester PHL telephoned Dr Fairfax to say the Preston Laboratory had conducted tests on the two sera which gave an indication of a recent infection. Although Dr Fairfax rang the registrar on duty Dr Rashed to tell him to put all the patients on intravenous erythromycin he did not convey the impression to his colleagues that the cause of the outbreak had been discovered. At a joint meeting of the Unit Management Teams of the SDGH and the SGI held later that day Dr Daggett advised that CDSC be called in to investigate the cause of the outbreak. He said in evidence "at that stage it appeared to me that we had an outbreak effectively running out of control with large numbers of admissions. We had no positive diagnosis. Patients were dying from this condition and I felt it was my responsiblity as the only clinician at the meeting to make the point".

99. As it happened Dr Scully had already been in touch with CDSC that day and had asked for assistance in investigating the outbreak. As a result Dr O'Mahony and Dr McEvoy arrived on the following day, Tuesday 30 April.

100. In response to the information from Manchester a further meeting of the CIC was held on Tuesday 30 April attended not only by the general physicians but also by the physicians from Kingsmead and Dr O'Mahony and Dr McEvoy. At the meeting the need to use intravenous erythromycin for all the patients was endorsed and Dr Scully was asked to write to the local general practitioners to put them in the picture. In his letter he pointed out that examination of the chest might reveal little and that therefore a chest X-ray would be helpful. He advised them that the recommended treatment for suspected cases was a combination of erythromycin and flucloxacillin. Unfortunately because of pressure of work this important letter to the family doctors was not sent out until 2 May, two days later.

101. Finally, at a meeting of the CIC on Friday 3 May the diagnosis of Legionnaires' Disease was firmly established. Dr O'Mahony reported that of the 50 specimens of serum sent to Manchester 9 had indicated infection with Legionella pneumophila. These 50 specimens were the 30 posted on Monday 29 April from Stafford and a further 20 sent by taxi the following Thursday, 2 May.

102. Thus, a whole week had elapsed between the arrival of the first few sera, which when tested had raised the possibility of Legionnaires' Disease, and the results on the next 50 specimens. We must conclude that if the same sense of urgency had prevailed in the Microbiology Laboratory at St George's Hospital as prevailed in the wards at the SDGH the diagnosis of Legionnaires' Disease might have been made a week earlier and precious time would have been saved (see Chapter 6, paragraph 135).

103. The Public Health Laboratories at East Birmingham, Manchester and Preston collaborated from the outset, they organised their work to cope with the heavy load of specimens from Stafford and brought in staff to work right through the week-ends. In contrast the staff of the laboratory at Stafford, although they became very busy sorting and collating specimens in the later stages of the outbreak, continued to work more or less normal hours in almost complete isolation from the clinical services. Apart from one or two brief appearances, the head of the Microbiology Department Dr Nnochiri played little or no part in organising, supervising or controlling the work of the laboratory, and the staff were left to cope as best they could by themselves.

104. At the CIC meeting on 3 May the clinicians were startled when, in answer to a question by Dr Fairfax, Dr Nnochiri informed them of the previous isolation of Legionella from the water sample taken from the SDGH cylinder 4 cooling tower pond in November 1984 (see paragraphs 60-66 above). Dr Daggett put their viewpoint at its most forceful:
"(my reaction) was astonishment followed by very grave anxiety. I think that if we had known that Legionella had been isolated at any stage from the hospital cooling tower system early in the epidemic we would have gone straight to a positive albeit tentative diagnosis and treated every patient much more aggressively with erythromycin and rifampicin. As it is, erythromycin and rifampicin are drugs with side-effects ... and they are not to be used without very careful thought unless you have a good reason for doing so".

105. It was thought that the information should have been conveyed to the CIC much earlier, and that it would have helped resolve the dilemma of finding a common link between the patients. On Saturday 4 May, the day following the CIC meeting, Dr Mason (Medical Registrar) and the other junior doctors interviewed as many of the affected patients as possible,

and surveyed their case notes. They came to the conclusion that a significant number of those who had been admitted to the SDGH and to the SGI had had a prior contact with the SDGH. Working independently Dr O'Mahony and her colleagues from CDSC had come to the same conclusion; so within two weeks of the beginning of the outbreak both the cause and the source of the infection had been discovered.

CHAPTER 5: EPIDEMIOLOGY OF THE OUTBREAK

106. Once the cause and source of the infection had been discovered, the first and most urgent task was to identify the patients involved in the outbreak so that the origin, course and outcome of their disease could be defined. In the event, this proved to be considerably less straightforward than might have been imagined. While the outbreak was in progress, the hospital had to cope not only with the admission of large numbers of patients with severe respiratory disease and a relatively high mortality rate, but also understandable demands from public and press for information. As mentioned in the previous Chapter daily statements were made which included the numbers of patients admitted and the numbers who had died. Because there is at present no rapid means of establishing the diagnosis of Legionnaires' Disease, the figures issued daily were necessarily based on the best combination of evidence available at the time. When the CDSC team arrived, it was decided that no further figures would be issued until criteria for the diagnosis and inclusion of patients in the outbreak were agreed amongst all those concerned. At that time a total of 94 patients admitted with 19 deaths had been reported in the press. The following account of the epidemiology of the outbreak is based on CDSC's fourth interim report.

Criteria For Determining Cases Of Legionnaires' Disease

107. The outbreak occurred at a time when other respiratory disease was also occurring, particularly in the elderly population. Therefore if progress was to be made in establishing the source of the epidemic, it was essential for all concerned to review each patient critically and decide whether or not the diagnosis of Legionnaires' Disease could be sustained. Even when all the laboratory information was available, some weeks after the epidemic, this task was hampered by the equivocal nature of some of the findings: for some patients with clinically convincing disease did not produce antibody titres which met the normal diagnostic criteria. Among patients with clinically similar disease, some showed incontrovertible evidence of Legionnaires' Disease while others showed very doubtful evidence or none. Some experts took the view that in the circumstances of an epidemic patients with convincing clinical manifestations should be included if there was any trace of supporting evidence from the laboratory. Unfortunately the magnitude of these difficulties, the uncertainity of the diagnosis in the majority of patients during and for some time after the

epidemic, and the need to revise the figures constantly as more evidence accumulated, were not explicitly conveyed to the public and press; and the release of different figures at different times, particularly of the number of deaths, understandably caused consternation.

108. The final decision as to who did and who did not contract Legionnaires' Disease in the course of the epidemic was made at a meeting on Saturday 21 September 1985 in Soke-on-Trent, attended by representatives of CDSC, MSHA and the various Public Health Laboratories involved in the outbreak. At the meeting the records of every patient with respiratory disease admitted during the epidemic period were again closely scrutinised and the patients assigned, with the agreement of all present, to one of five categories. By then the epidemic was identified with the SDGH, and the first criterion for inclusion as a patient involved in the outbreak was prior contact with the hospital. Patients admitted to hospital were divided into six categories numbered 0-5. Cases of Legionella infection considered to be part of the outbreak fell into three groups: definite (category 5) presumptive (category 4) and possible (category 3). Patients in category 2 had chest infections but no supporting evidence of Legionella infection. Patients in category 1 had non-specific respiratory symptoms and no supporting evidence of Legionella infection, while patients in category 0 had a chest infection or pneumonia but no exposure to the SDGH.

109. The criteria for the definite diagnosis of Legionella infection were clinical evidence of pneumonia or chest infection supported by serological evidence of infection of a four-fold rise in immuno-fluorescent antibody titre (IFAT) to at least 1 in 64 or a reproducible titre of at least 1 in 128 on a single serum specimen using Legionella pneumophila serogroup 1 antigen. The serological criteria for presumptive (Group 4) cases included patients who, a Rapid Micro Agglutination Test (RMAT) result of 1 in 32 within two weeks of the onset of illness, a sustained rise on IFAT to 64 or the finding of a positive direct immunofluorescence on post mortem lung in association with exposure to the SDGH. For the purpose of the case-control and cohort studies (see paragraph 113 below) only patients with definite or presumptive evidence of Legionella infection were classified as cases. In patients not admitted to hospital, the criteria were clinical evidence of chest infection supported by a serum IFAT titre of 1 in 64 and associated exposure to the SDGH.

Dimensions Of The Outbreak

110. Within these criteria, the dimensions of the outbreak can be established. First, 175 patients were admitted to the SDGH or Kingsmead Hospital between 18 March and 20 May with a diagnosis of chest infection or pneumonia (see figure 3). Of this group, 56 were confirmed as cases of Legionella infection. Second, among patients who were admitted for surgery and who developed chest infections post-operatively, 3 further cases were confirmed. Third, amongst patients treated in hospitals outside Stafford, there were another 9 such cases. In all therefore, among persons admitted to hospitals, there were 68 confirmed cases of Legionella infection. To those 68, another 19 cases could be added in whom there was a strong presumptive clinical diagnosis of Legionella infection, although all the criteria for a laboratory diagnosis could not be met, so that amongst hospital patients a total of 87 were considered to be part of the outbreak. Turning to persons who were not admitted to hospital, information was obtained on 29 patients attended by general practitioners: 14 of them were confirmed as cases of Legionella infection, all of whom had visited the SDGH in the two weeks before the onset of illness. Thus the total number of cases regarded as being part of the outbreak amounted to 101 (68+19+14).

111. CDSC made a careful analysis of the 68 confirmed cases among hospital patients. Of the 68 patients, 41 were males and 27 were females. A total of 28 patients died, 22 (32%) definite cases and 6 (32%) possible cases. The age range for females with confirmed infection was 39 to 88 years, average 62 years, median 64 years; for males, the age range was 36-86 years, average 67 years, median 67 years. All 68 patients had been to the SDGH, 58 patients had visited the OPD, 45 as out-patients and 13 as accompanying relatives or friends. Of these 58 patients, 47 had attended clinics within the shaded area of figure 4. Of the remaining 10 patients who had contact elsewhere in the hospital, 6 were in-patients and 4 visited relatives on different wards.

112. There was in the Stafford outbreak an epidemiologically valuable feature: with few exceptions, the day on which each patient was infected could be precisely identified. Commonly in an outbreak of disease, the day of infection of each patient can be estimated only by backward projection of the incubation period from the first day of symptoms. In Stafford, however, the great majority of the affected patients had no reason to visit the hospital more than once within the relevant period, so that the day on which they were infected can be uniquely identified. Among the 68 definite

(Group5) and presumptive (Group 4) cases, there were 5 whose precise date of exposure in the hospital could not be identified either because they were in-patients or because they attended on several occasions over the period of 28 March to 24 April 1985. The remaining 63 patients all attended or visited hospital between 9 and 19 April (figure 3) and thus the main dissemination of infection was over before the existence of the outbreak was recognised.

Case Control Study

113. The CDSC team also mounted a case-control study, designed to test the hypothesis that the SDGH, and particularly the OPD, was associated with Legionella infection. Two controls, matched by sex and age within 10 years and living in the same neighbourhood, were selected from the Family Practitioner Committee list for each serologically diagnosed case. Each person was interviewed using a standard questionnaire, which included questions on other potential environmental sources of Legionella, and blood samples were taken from the controls for the estimation of antibodies to Legionella pneumophila.

114. There was a significant association between visiting the SDGH and the onset of infection (Table 1). Within the SDGH the OPD was the only area significantly associated with Legionella infection. Only one patient sat near an open window in the consulting room or general waiting area in OPD. During their visits to the hospital, 22 patients used the toilet or wash hand basin facilities in OPD or elsewhere in the hospital.

115. Pre-existing chronic illness and cigarette smoking were also associated with Legionella infection (Table 1). Between cases and controls there were no significant differences in exposure to potential sources of Legionella pneumophila in the community.

Surveys Of Patients And Staff

116. The CDSC Team also conducted large scale surveys of patients and staff. A total of 10,834 out-patients attended the hospital between March and May 1985 of whom 7,358 (86%) returned a completed questionnaire. "Flu-like" illness was reported by 3.7% of patients who attended in March, by 9.3% in April and 2.3% in May. Reported "flu-like" illnesses were most frequent following appointments in the second, third and fourth weeks of April. The rates did not vary between different areas of OPD except in the second and third weeks of April, when there was an association between reported illness and visits to the ECG department for men aged 40-64 years.

117. The only out-patients for whom systematic serological testing could be carried out were women who attended for antenatal care and who were admitted for delivery between July and September 1985. Of the 230 women in the study, 35 (15%) had raised antibody titres to Legionella pneumophila, 28 of whom were known to have attended clinics at the SDGH before May 1985: detailed information on other visits to the hospital was not available.

118. Completed questionnaires were received from 1,135 (72%) out of a total of 1581 staff based at the SDGH. Altogether, 790 were tested serologically, and 329 (42%) had an antibody titre of 1 in 16 or greater; the proportion who were serologically positive was generally slightly higher in those reporting an illness between December 1984 and May 1985 (a high number when compared to the same period twelve months earlier) and a significant association with seropositivity was observed for "flu-like" illnesses in March, although they accounted for only a small proportion of seropositive staff. The highest proportions of positive serology were observed in staff working in OPD, medical records, operating theatres, maintenance, pharmacy, administration, X-ray and in the post-natal ward on the second floor. Further analysis of nurses, who formed the largest group of staff at the SDGH, confirmed that positive serology was independently associated with working in the OPD areas, operating theatres and Ward 9 of the Maternity Unit (Table 2).

Summary

119. For the purposes of our Inquiry into the cause of the outbreak, we have extracted from this epidemiology two key facts. First, the confirmed cases were infected during the period 9 to 19 April, so that the outbreak ceased before its existence became known and well before any preventive measures were taken. Second, there was a strong association between infection and exposure to the cylinder 4 air conditioning systems. With respect to patients, such exposure was principally in the area served by the OPD air conditioning system; with respect to staff, the exposure extended to other areas on the first and second floors which were also served by other air conditioning systems supplied by cylinder 4.

CHAPTER 6: COMMENTS ON THE MEDICAL AND MICROBIOLOGICAL ASPECTS OF THE OUTBREAK

The First Isolation

120. So soon as they learned in January 1985 of the isolation of Legionella pneumophila from the sample taken from the pond of the cylinder 4 cooling tower water system on 12 November 1984, the hospital engineers acted properly and promptly in informing Drs Scully and Nnochiri and in implementing measures which they believed would be adequate to remove the contamination. We are concerned that the fact of an isolation was not routinely reported to the next ensuing meeting of the CIC. Several points arise from this: first Dr Nnochiri claimed that he had not been told of the isolation; our conclusion that he had been told is already recorded. Second, while we appreciate that Dr Scully properly advised the engineers to report the isolation to Dr Nnochiri as the Consultant responsible for hospital infection, we remain concerned that he did not react to and rectify Dr Nnochiri's failure to report it to the next meeting of the CIC. Third, we accept that for both doctors, knowledge of the ubiquitous presence of this organism may have served to lessen the impact of the fact of the isolation; nonetheless the fact that Legionella should have been found in the cooling tower of a new hospital ought to have raised immediate questions about the efficacy of current operational and maintenance practices, and it ought further to have raised a concern about the need for routine testing, both matters for the CIC.

The Administrative Response To The Outbreak

121. The initial response by clinicians, nurses and hospital management to the sudden admission of large numbers of patients with severe respiratory infection was excellent. The available facilities were used efficiently and flexibly to meet the demands.

122. It was clear to us that the patients and their relatives had nothing but praise for the nurses, doctors and other staff who looked after them on the wards.

123. We concur with the view of the physicians that the management of the outbreak would have been much more efficient had there been overall central control. We believe that a "Crisis Management Team" should have been set up at an early stage, chaired by a senior physician, who should have been relieved of most of his other duties. The membership of the Team should have included the Consultant Microbiologist and the Medical Officer for Environmental Health (or their representatives), a Senior Nurse, a Senior Administrator, and representatives from the SGI and Kingsmead Hospitals. The Unit Management Teams would have continued to function normally and would have protected the Crisis Management Team as far as possible from all duties not connected with the outbreak.

124. The team should have had a duty to:-

i) dispose of the facilities and personnel available;

ii) co-ordinate the investigation and the management of the patients in all the hospitals;

iii) co-ordinate policy for laboratory investigation in order to avoid the independent involvement of several laboratories with the concomitant risk of duplication, confusion and delay in obtaining results;

iv) consider the need to seek the assistance of specialist clinical (in this instance, infectious disease) and microbiological advice;

v) involve the services of CDSC and co-ordinate the various investigations;

vi) co-ordinate the keeping of records and the dissemination of accurate and speedy information to the patients, their relatives and the public.

125. The Crisis Management Team would have been able to co-ordinate the investigation of Dr O'Mahony and her colleagues from CDSC, the activities of the physicians and the attempts by Dr Scully and Mr Bartlett to keep the public and the media informed about the progress of the outbreak. Once the diagnosis of Legionnaires' Disease had been confirmed the membership of the Team could have been altered or enlarged to bring in additional engineering expertise. For example under the chairmanship of an administrator it could have instituted engineering investigations to define the possible sources of the infection and the routes of its dissemination so that the hospital could be made safe as soon as possible. Under strong central direction questions about the use of the hospital after the disease had been confirmed would have been more easily answered, and the problems posed by the anxiety of the patients and staff on one hand and the interest of the press and media on the other would have been easier to solve.

126. Had this been done:-

i) there would have been a definitive master list of the patients affected;

ii) information about the outbreak in general and individual diagnoses in particular would have been updated and imparted regularly as it became available;

iii. authoritative statements could have been made about the prognosis of those affected and where applicable about the problems posed by the system of certification of deaths;

iv) MSHA's efforts to meet the legitimate inquiries of the public would have been more effective.

127. The outbreak at Stafford highlights the need for all District General Hospitals to prepare a plan to deal with serious medical emergencies analogous to those which already exist for major accidents. An administrative framework should be prepared and the person responsible for convening the emergency team identified. The exact composition of the team could be modified as required to fit the circumstances of each particular emergency. See Recommendation 1.

The Diagnosis And Management Of Patients

128. Criticism has been levelled at the delay in arriving at the correct diagnosis and initiating the most appropriate treatment.

129. The explanation for the delay that was given to us in evidence was that in the early stages laboratory support for the diagnosis of Legionnaires' Disease was weak, there was no evidence of a common source of infection, and the presumptive diagnosis of influenzal pneumonia was supported by the initial results from the Birmingham PHL and the weekly Communicable Disease Report issued on 26 April (showing a fourfold increase in the national prevalence of influenza).

130. In the early stages of the outbreak, and until the diagnosis of Legionnaires' Disease was definitely established on 29 April, we were told that intravenous erythromycin was excluded from the antibiotic regime because of concern about its use in elderly patients with impaired renal function, and because of the belief that the patients were suffering from influenzal pneumonia.

131. In our view the criticism mentioned in paragraph 128 above was not well founded. Nevertheless we consider that the physicians might have been helped to reach the correct diagnosis more quickly if they had sought early advice from a specialist in infectious disease (see recommendation 2).

Knowledge Of The Earlier Finding Of Legionella

132. The view was canvassed before us that had the physicians known at the beginning of the outbreak that Legionella had been found in a water sample taken the previous November from the pond of one of the cooling tower water systems at the SDGH, they would have considered the diagnosis of Legionnaires' Disease more likely and would have been more inclined to include intravenous erythromycin in their antibiotic regime.

133. However, as stated above, in the early stages of the outbreak they were strongly of the view that the patients were suffering from influenzal pneumonia; there was no evidence of a common source of the infection, and they were not greatly influenced by the initial laboratory evidence of Legionnaires' Disease. In view of all these factors we are inclined to wonder whether knowledge of the previous isolation of Legionella would have influenced them very much.

134. Nonetheless we are of the opinion that in the presence of an outbreak of severe undiagnosed respiratory infection it was important that information about the previous isolation should have been made available. We consider it should have been reported to the members of the Control of Infection Committee at its first emergency meeting on Friday 26 April.

The Stafford Microbiology Laboratory At St George's Hospital

135. The contribution of the Microbiology Laboratory at St George's to the investigation and management of the patients and of the outbreak was less effective than it should have been. A number of factors which adversely affected the performance of the laboratory emerged in evidence:-

i. The laboratory was on a different site from the two acute hospitals, the SDGH and the SGI;

ii. Dr Nnochiri was responsible both for the laboratory at Stafford and that at Burton, 20 miles away;

iii. Dr Nnochiri's relationships both with the clinicians and the laboratory staff were such that he did not undertake the central role in the outbreak that might have been expected of him as Consultant Microbiologist and Chairman of the Control of Infection Committee;

iv. there were direct approaches by physicians to outside laboratories which bypassed, and were unknown to, the Stafford laboratory;

v. there was undue reliance by the laboratory on routine postal services for urgent specimens;

vi. the staff of the Stafford laboratory failed to appreciate the fact that the emergency existed - at least until the week beginning 29 April - and therefore showed no sense of urgency;

vii. the post of Control of Infection Technician had been abolished, thus severing a useful link between the laboratory and the clinical services;

viii. the isolation of the Stafford laboratory was increased because Dr Solaro did not undertake liaison with the clinicians as part of his training.

136. Our recommendations 3, 4 and 5 (see Chapter 13) follow from the above.

The PHLS Laboratories

137. Great assistance was provided in the establishment of the diagnosis of Legionnaires' Disease and in the subsequent investigations by the PHLS Laboratories in East Birmingham, Manchester and Preston. We pay particular tribute to the Directors and staff of those laboratories who gave unstintingly of their time and expertise in support of those grappling with the Stafford crisis; and we note the importance of the provison by the PHLS of reference facilities and expert advice freely made available to all, and the benefits of easy communication provided by the existing PHLS network.

General Comment

138. There are two general matters that have an important bearing on the investigation and control of epidemics of infection to which we make brief reference here (though we make no specific recommendation on either) and to which we may return more fully in our second Report if the evidence justifies our doing so.

139. The first is the role of the MOEH. Evidence we heard and submissions made to us lead us to believe that the responsibilities and authority of the MOEH need to be reviewed. We also believe that there is legitimate concern that the present training and experience of MOsEH is less effective than that formerly provided in fitting them to undertake responsibilities for the investigation and control of outbreaks of infection.

140. The second is the role of CDSC. It seems to us that it needs to be considered whether there should be an obligation to consult CDSC in the event of a major outbreak of infection. If such a requirement were to be contemplated, consideration would have to be given, amongst other matters, to the definition of 'major outbreak', the relation of CDSC to existing sources of advice including local microbiology laboratories and the effect on the scale and scope of CDSC itself.

CHAPTER 7: THE HISTORY OF THE SDGH, RELATED TO CONTEMPORARY KNOWLEDGE OF LEGIONNAIRES' DISEASE

141. The history of the SDGH started in the late 1960s with discussions between the Birmingham Regional Hospital Board, responsible for planning major new buildings in the Region, and the DHSS who control the allocation of resources and issue national guidelines on design, construction and other aspects of health service buildings. In July 1971, after funding was approved, the Board engaged Building Design Partnership (BDP) as architects, consulting engineers (mechanical, electrical, civil and structural) and quantity surveyors for the new hospital.

142. The designer of any hospital seeks to ensure that the functions specified for the hospital can be performed safely and efficiently within as pleasing an environment as possible. In doing so the designer takes account of the resources available, the design guidance issued by the DHSS, and the latest technology.

The "Harness" Design

143. BDP were required to build the new Stafford Hospital on the "Harness" model. In about 1970, when a number of new hospital buildings were being planned, this model was developed by DHSS to provide an economic and flexible design capable of being adapted to the requirements of a number of different sites (see Appendix 6). It consists of a number of standardised units ("Harnesses") attached to a central covered "street" (see figures 5 (a) and (b)). The street provides routes of communication within the hospital, including lifts and staircases, and also contains the main engineering services which are linked to the service cylinders placed at intervals along the street. The units attached to the street contain the various hospital functions; but to provide flexibility of use the size and configuration of each unit is such that it is necessary to provide a mechanical system of ventilation and air conditioning.

144. The "Harness" design concept was never fully developed, being superseded after about five years, and only two hospitals conforming to it were ever built, one being the SDGH. Therefore in converting the design intention into a technical concept it was necessary for BDP to develop

certain design features of their own, for example the service engineering installations. In developing their overall technical concept BDP relied on conventional, well-proven, technology, including "wet" cooling towers to provide the air conditioning. The commitment to use a water cooling system for the air conditioning plant was made in late 1974 early 1975, and BDP stated that it was the only type of equipment available at the time: air-cooled systems only becoming an option for hospitals in the late 1970s.

145. The process of converting the original design concept for the hospital into a detailed building specification took over five years, from July 1971 to December 1976. During this period (in April 1974) the National Health Service was reorganised and the West Midlands Regional Health Authority was created, subsuming among other things the Regional Hospital Board's responsibility for major new building work.

146. Between December 1976 and October 1977 the building design was documented and approval was given to proceed to tender. It was during this period, in January 1977, that the first isolation of the Legionella organism was made, following a convention of American Legionnaires in a Philadelphia hotel in July 1976. The first confirmed cases of Legionnaires' Disease in Great Britain were reported in August 1977 (Glasgow) and November 1977 (Nottingham).

147. Following the tendering period (November 1977 - May 1978), work started on site in September 1978. Fairclough Building Limited were appointed as the main contractor responsible for construction of the hospital, and Andrews Weatherfoil Limited as the sub-contractor for mechanical engineering services. A number of specialist firms and suppliers of equipment were engaged by Andrews Weatherfoil Limited including Cool Technology Ltd (the cooling towers), Hotchkiss Ductwork Ltd (the ventilation ducts), American Air Filters Limited (AAF) (the chiller batteries) and Satchwell Controls Limited (the controls). We describe in detail a typical ventilation and air conditioning system at the SDGH in the next Chapter.

148. In November 1980, midway through the Hospital's 4-year construction period, the DHSS issued a circular, HN(80)39, containing guidance to Health Authorities on measures to be taken to reduce the chances of an outbreak of Legionnaires' Disease. The circular was prompted by an outbreak of the

disease at Kingston Hospital earlier in the year. The history and significance of the circular is discussed in Chapter 9; here it only need be noted that the circular referred to the association between outbreaks and cooling tower water systems and domestic water supplies; and recommended that cooling towers should be inspected, cleaned and chlorinated twice a year and domestic hot water stored at 60°C and distributed at not less than 50°C. We heard in evidence that BDP and the West Midlands RHA considered the circular to be concerned only with operational and maintenance procedures and at the time of issue the only practical consequence for the hospital's design was the raising of the temperature at the distribution point of the hot water system in the children's ward from 40°C to 55°C (temperatures elsewhere were already designed to be at 65°C).

"Building Services" Article On Legionnaires' Disease

149. Four months later, in March 1981 "Building Services", the journal of what was then the Chartered Institute of Building Services, contained an article on Legionnaires' Disease which concluded that engineers could minimise the likelihood of future outbreaks by, among other things, siting water cooling towers at a distance from - and downwind of - fresh air inlets. By that stage however the construction of the SDGH's cooling towers was well advanced. In evidence BDP told us that they considered the design - already 7 years old - of the hospital's cooling towers to be reasonable when judged against the "Building Services" article. BDP also referred to a publication in December 1982 by the Building Services Research and Information Association (BSRIA) on Legionnaires' Disease, which in their view was the first comprehensive UK document dealing with the disease from the viewpoint of engineers. In the document designers of new buildings were told to ensure that adequate provision was made for cleaning and maintaining engineering equipment. By this time the construction of the hospital was virtually complete, and indeed a month before the document's publication date the hospital's Certificate of Practical Completion was issued.

Commissioning

150. Before the building was completed and the hospital handed over in November 1982, a 30-week period was specified in the contract for commissioning, that is, for ensuring that the hospital was in full working order and providing sufficient time for experience to be gained of its operation. Any adjustment needed at this stage would be put right during the subsequent 12-month "defect liability" period.

151. We heard in evidence that the main responsibility for commissioning the hospital lay with Andrews Weatherfoil Limited, though supported by BDP and the Regional and District Health Authorities. In a document agreed by all those parties and prepared at our request we were informed that commissioning, which was to be conducted in two stages, began in November 1981 but was delayed until March 1982 by bad weather. We were further told that although 12 months was the preferred timespan for commissioning, a period of 7 or even 6 months was not unusual. We comment on the commissioning process in Chapter 12.

152. We accept that when the construction is not completed on time and therefore runs into the period allowed for commissioning, in a complex building it is not unusual for the two stages to proceed concurrently for a while. In such instances, and indeed as they did on the SDGH site, the consultants and contractors may take on extra staff to complete the work. However, we consider that although that action may ensure the building is ready for handover on the scheduled date, it imposes extra pressure on all parties, notably on the hospital operational engineers who in due course become responsible for operating the building. Ordinarily they would use the commissioning period to gain from the designers and constructors an understanding of the way the building engineering systems operate; where the period is shortened the acquisition of understanding may be adversely affected. For example, the extra staff taken on would have been unlikely to be able to explain to the operational engineers the intended operation of the plant, while at the same time by enabling construction to proceed on several fronts simultaneously the opportunities for the operational engineers to learn by observation were reduced. At the SDGH this situation was exacerbated by the novelty and complexity of the engineering plant. For following handover the operational engineers had to establish the appropriate procedures by their own efforts since written operating

instructions were not made available at that time. At the same time the hospital's engineering plant needed to be operated at a high level of efficiency as soon as it was opened, when many other systems with which we were not concerned were making similar demands upon them. The situation was further aggravated by the pressures on the operating engineers to maintain services while the defects which came to light after the Hospital became operational were put right. We further think that the foreshortening of the commissioning period led to self-contained but constituent parts of certain systems being tested individually without such systems being tested as a whole.

The Defects Following Handover

153. Various defects appeared on the list of "snags" which was prepared by BDP and the RHA/DHA engineers and appended to the Certificate of Practical Completion. In particular our attention was drawn to a problem experienced in the summer of 1983, when during a heat wave large quantities of condensate water were discharging from the chiller batteries and associated ductwork, with which the existing drip trays for collecting condensate water could not cope. AAF, manufacturers of the chiller batteries and sub-contractors to Andrews Weatherfoil Limited, corrected the problem by applying an insulant called "Densofil" to the return loops of the chiller coils and by fitting supplementary drip trays underneath the return loops at both ends of the main drip trays. These new trays connected into the existing drainage system from the chiller battery trays to the main plant drainage stack. Remedial alterations to the ductwork were also carried out.

154. Various other defects came to light after handover and were the subject of correspondence between the Health Authority, BDP, the contractors and sub-contractors. We have seen much of the correspondence and have concluded that it is not relevant to our Inquiry, except insofar as we have noted the complexity of operation of the Hospital, the many problems that occurred once it had become operative, and the consequent demands thereby made on the hospital engineers.

155. The first patients were admitted in May 1983. Remedial work was still being carried out at the time. "Operation and maintenance manuals" for the hospital were eventually handed over by Andrews Weatherfoil a year later, in about May 1984. They consisted predominantly of component manufacturers' literature, and not of the system operation instructions which the hospital engineers needed.

CHAPTER 8: THE AIR CONDITIONING SYSTEM AT THE SDGH

156. The "Harness" design allows great freedom in planning the arrangement and location of spaces within a hospital. However because of the width and depth of the rooms which may result from this design there is a need to provide them with an air conditioning system in order to maintain a comfortable environment.

157. The essential elements of any such air conditioning system are:

i. a fresh air inlet point (figure 6). The air has to be collected from outside the building. The collection point is usually above roof top level where the air is considered to be reasonably clean. But as was made clear in "Building Services" in 1981 (see paragraph 149), the location of this air inlet point in relation to the cooling tower is important;

ii. ducts (figure 6). The air has to be conducted by a system of air ducts from the air inlet point to the spaces where it is needed;

iii. silencers (figure 7) are used to limit the transmission of noise along the ductwork;

iv. dampers (figure 7). A damper is a device similar to a door which when closed enables a section of ductwork or plant to be isolated from the main operational system;

v. filters (figure 7). However clean the air may be at the air inlet point it is likely to need cleaning, by means of filters, before it is put to use (for example in operating theatres);

vi. heaters (figure 7). To maintain control of the temperatures in the occupied spaces, facilities are needed for heating the air (by means of a heater battery);

vii. fans (figure 7) are need to drive the air along the ducts;

viii. chillers (figure 7). To maintain control of the temperatures in the occupied spaces, facilities are needed for cooling the air (by means of a chiller battery);

ix. a refrigeration unit(figure 8) is required for extracting the heat from the chiller battery;

x. a cooling tower(figure 8) dissipates the heat extracted from the chilled water circuit by the refrigeration unit.

158. In large and complex buildings like hospitals it is usual to install several air conditioning plants each serving a separate zone of the building. By such means not only is the size of each plant kept within reasonable limits but usage is made more flexible and economical as well; because if only part of the building needs to be air-conditioned the plants serving other zones can be switched off, and indeed a programme of maintenance can be carried out without the need for more than one plant or system to be taken out of action at a time. At the SDGH there are in fact 4 separate systems, one in each of the four service cylinders, and each serves a separate zone of the hospital.

159. Within each zone there is further subdivision. At the SDGH, each floor served by cylinder 4 has a separate air conditioning plant, capable of operating independently of the others and linked to the respective requirements of each floor but served from a common cooling tower and refrigeration unit (see figure 9). Thus it was intended that the operating theatres on the first floor should be air-conditioned 24 hours a day, seven days a week; the air-conditioning of the maternity wards on the second floor should operate in the same way; but on the ground floor in the Out-Patients Department it was intended to provide air conditioning only from 09.00 hrs to 17.00 hrs, Mondays to Fridays.

160. Each service cylinder at the SDGH has a single fresh air inlet point above rooftop level which draws air into a vertical duct serving all floors. The air conditioning plant on each floor draws air from this common inlet duct, "conditions" it, and delivers the conditioned air to the wards and other rooms it serves. Air is drawn out of the vertical inlet duct by each plant's fan (the isolating damper having first opened), through a silencer and filter and is then heated or cooled as necessary. The heater or chiller battery is brought into operation by the appropriate, preset, temperature sensor.

161. The chiller (figure 10) consists of a coil inserted into the ductwork through which chilled water is circulated to remove heat from the air flowing over it. The water from the coil is pumped up to a central plant room at rooftop level in the service cylinder. There the heat which the chiller coil has taken out of the air is removed from the water via a refrigeration unit, so that the now re-chilled water can be recirculated for cooling the air in the ductwork below.

162. The heat extracted from the chilled water by the refrigeration unit is transferred into a separate water circuit which is part of the cooling tower system. This heat is removed in the cooling tower by cooling the water in that circuit. The general principle is that the water is cooled by being pumped to the top of the tower into a pipe containing a number of spray nozzles. The water sprays down from the pipe over packing (which provides a large evaporative surface designed to maximise heat loss from the water) into a pond at the bottom of the tower. At the same time if the heat load is sufficiently great a fan at the top of the tower operates to draw air from inlets in the sides and close to the base of the tower, through the downward-flowing shower of warm water and expels it through vents or flaps in its roof. The upward passage of the external air removes the heat from the descending water. The now cooled water from the pond is then pumped back through the refrigeration unit.

163. In order to replenish the loss through evaporation or drainage, the pond is kept topped up with fresh make-up water by means of a ball valve linked to the incoming pre-softened mains water supply. The pond can also be emptied manually or automatically (there is also provision for overflow drainage) into a drainage stack running vertically downwards through the entire service cylinder into the main underground plant drain for the whole hospital. Connected to this vertical stack at a lower level are the drains from the chiller battery drip trays on each floor which collect the condensate water from the chiller coils (figure 11).

CHAPTER 9: HOSPITAL OPERATION AND MAINTENANCE: HN(80)39 AND THE BIOCIDE REGIME

Introduction

164. In this chapter we discuss two particular aspects of the operation and maintenance of the SDGH which have a general bearing on the cause of the outbreak, and which form part of the essential background to the story of the outbreak as told in Chapter 10.

PART I: DHSS HEALTH NOTICE (80) 39

165. From its issue in November 1980 until after the Stafford outbreak was over (when it was supplemented by two Hazard Notices, issued in July 1985 and January 1986), this Health Notice (reproduced at Appendix 5) was the only specific guidance made available by the DHSS to Health Authorities on the measures necessary for reducing "the chances of an outbreak of Legionnaires' Disease occurring." Because of its importance in this respect, we have carefully inquired into its origins, subsequent history and efficacy.

Origins

166. During 1980 because of the markedly increasing number of confirmed cases of Legionnaires' Disease, in particular those associated with hospitals, the DHSS convened a meeting of experts to devise guidance for issue to Health Authorities on suitable preventive measures, and to determine appropriate areas for research into the origins of the disease. Following a meeting on 16 September 1980 between administrative and professional staff in DHSS and experts in this field, draft guidelines were finalised and promptly published in November 1980 as this Health Notice. We consider the Notice represented a speedy response to the growing threat from a newly-defined disease, and in those terms it was reasonable for it to have been disseminated following relatively modest preparation.

Subsequent History

167. At the meeting on 16 September 1980, Dr C Bartlett of CDSC indicated that funds were being sought (by the PHLS) to support a research study on Legionella pneumophila in water systems and air conditioning equipment. By

October 1981 the DHSS had agreed to fund such a study over a two year period at a cost of £92,188. On 7 September 1983 Dr Bartlett provided the DHSS with a progress report stating that the primary objectives of the study were:

"i. to determine how frequently Legionella pneumophila may be found in plumbing systems and air conditioning equipment;

ii. to identify design features and other factors which permit growth and establishment of the organism in such systems;

iii. to determine whether Legionella is introduced in the potable mains supply or from extraneous sources."

168. The secondary objectives were stated to be:-

"i. to develop improved methods, ideally using in vitro systems, for the isolation of Legionella species from water and other environmental samples;

ii. to develop expertise in the surveying and sampling of complex building services, such as hot and cold water systems, which could be called upon during the investigation of outbreaks of Legionnaires' Disease."

169. The report said that although the project had been delayed by staffing difficulties the secondary objectives had already been met and two interim papers had already been published. It concluded: "It is proposed that field work should cease in August 1984. This will be followed by a period of up to six months for comprehensive analysis of the data and it is expected that a final report will be submitted to the DHSS in late 1985." It is now common ground between Dr Bartlett and the DHSS that this latter proposal was agreed to, so that the final report was not due until late 1985.

170. The above account is important because we believe that the DHSS intended to review the guidance in the Health Notice in the light of this final report, initially expected to be received after two years, that is in 1983. However in the event it appeared that receipt of this final report became for the DHSS (without consultation with or encouragement from Dr Bartlett) a pre-condition for any review of the Health Notice. Thus, given that no such report had been forthcoming, there had been no review, and at the time of writing we believe that the situation has not changed (although we understand Dr Bartlett's final report has now been recieved by the DHSS. In Chapter 12 we comment upon this state of affairs.

171. To make the matter worse, within DHSS it was mistakenly thought that this final report would be available in late 1984 and not late 1985 with the result that throughout the greater part of our public hearing the DHSS's delay in reviewing their Health Notice was wrongly attributed to delay on the part of Dr Bartlett in concluding his research study. Although Dr Bartlett was on secondment in Trinidad until after our hearing in the autumn was concluded, contact was made with him there which resulted (on 2 October 1985) in his solicitor putting before us what we now believe to be the true timetable for the research (set out in paragraph 169), and his expectation of keeping to it. DHSS accepted Dr Bartlett's statement and apologised to us for supplying incorrect information.

172. In addition to making the receipt of Dr Bartlett's supposedly overdue report a pre-condition for its revision, the DHSS believed that the terms of the Health Notice constituted a code of practice - erring if anything on the side of caution - which was capable of being adopted as such by hospital engineers. Dr D W Zutshi, a Senior Medical Officer in the DHSS, contended to us that there had been no reported outbreak of Legionnaires' Disease in establishments which complied with the guidance given in the Notice. From that standpoint there could be no urgent need to review HN(80)39. We comment on the foregoing in Chapter 12; here we consider the question raised by Dr Zutshi's contention, namely the efficacy of the Notice.

Efficacy

173. The key provisions in the Health Notice are:-

a. "Twice yearly or at the beginning and end of each season and when shut down for any significant length of time for any other reason" a cooling tower "should be disinfected by chlorination to five parts per million, drained, thoroughly inspected and cleaned..."

b. Anti-scaling compounds and algicides should be used after such cleaning.

c. Cold water should be kept and distributed at a temperature "down as near to 20°C as possible" and should not be subject to local abnormal temperature rises.

d. Hot water should be stored at a temperature of 60°C and distributed at a temperature not less than 50°C.

174. We have the following comments on provisions (a) and (b):-

i. Re-drafting is needed to emphasise that chlorination follows as well as precedes draining, inspection and cleaning;

ii. "Chlorination to five parts per million" is not a definitive requirement. Whatever was originally envisaged (and in the circumstances vagueness was understandable) we would add "of free residual chlorine", for the efficacy of the added chlorine decreases rapidly as the pH rises above 8;

iii. "Thoroughly inspected and cleaned" require expansion so as to specify for the hospital engineers who have to operate the system the type of inspection and the method of cleaning necessary to reduce the risk of contamination. A statement should be included to the effect that the measures advocated will merely serve to reduce this risk, not to eliminate it;

iv. The Notice only specifies the use of anti-scaling compounds and algicides after cleaning and gives no guidance on subsequent regular draining and replenishment, or the need for regular dosing thereafter.

v. We draw attention to the only use envisaged for biocides, namely as a possible response to an outbreak (paragraph 3 of the Notice) but not apparently as part of a regular preventive regime.

175. On 30 January 1986 the DHSS issued HN(Hazard)(86)1 "Legionnaires' Disease: Interim Engineering Guidance Note No 2: Cooling Towers and Evaporative Condensers" (reproduced at Appendix 7) which incorporates many of these points. We commend this document as representing good current practice.

176. On the evidence before us, we do not comment upon provisions (c) and (d), although in relation to provision (d) we note that at the end of 1982 a Meeting of the West Midlands Regional Cross Infection Services Committee approved a paper prepared for it by Professor G Ayliffe and Dr J Hutchison entitled 'Legionnaires' Disease in Hospital'. This paper urged in general terms that hot water need not be maintained at the level recommended in HN(80)39. Dr Nnochiri, a member of the Committee, passed a copy to Mr Denne as District Works Officer and asked him "to incorporate the recommendations" in the existing control measures. Mr Denne naturally sought further guidance in response to which Dr Scully sensibly advised that the paper's recommendations should be directed in the first instance to the DHSS for their evaluation and that in the meantime Mr Denne should continue to be guided by the Health Notice. We did not have evidence of the receipt by the DHSS of the paper but in any event it does not purport to give positive guidance for operational engineers.

177. Overall we would not fault HN(80)39 as an urgent, essentially short-term response. But it should have been revised in the light of new knowledge, and it should not have been allowed to stand as the only guidance from the DHSS for five years. We write 'the only', given that Estmancode has not been amended nor has there been any subsequent guidance as presaged at various places in the text (except for the Hazard Notices, HN(Hazard)(85)6, issued on 9 July 1985, and HN(Hazard)(86)1, issued on 30 January 1986). Further, the wording of the Health Notice offers scope for various interpretations to be put upon it, and the one selected will inevitably reflect the degree to which the engineers responsible for implementing the Notice understand the extent of the risk: the text invites the sort of intervention described in paragraph 176 above. Our comment upon the role of the DHSS in this matter is deferred to Chapter 12.

PART II: BIOCIDES

Introduction

178. This part of our Report is concerned with so much of the SDGH water treatment programme as related to the cooling tower water system in cylinder 4. We recognise that this is only one aspect of a much larger programme about which we make no comment.

Efficacy Of Biocides

179. Evidence was put before us that certain commercially produced biocidal compounds had shown under laboratory conditions a capacity for killing or inhibiting the growth of Legionella pneumophila in water (depending on the size of the dose). Kortokil 2020, manufactured from materials supplied by Boots PLC and marketed by water treatment specialists Fospur Limited ("Fospur"), was one such. Its efficacy in this respect was confirmed by tests conducted by CAMR in October 1985 which concluded that if Fospur's recommended dosing regime of 100-250 ppm at 1 to 4 weekly intervals was followed it was "reasonable to expect Kortokil 2020 to kill or at least to markedly inhibit Legionella in a clean, well maintained system".

180. We have kept an open mind to the question of Kortokil 2020's efficacy in the field. Although we heard of a claim by another company that the efficacy of their product had been demonstrated under field conditions, we noted that by the date of our Inquiry Fospur made no such claim. While we acknowledge the difficulty of setting and maintaining suitable conditions for field tests, we consider it important that a biocide is shown to be effective in the field as well as under laboratory conditions.

Introductory History

181. The Water Treatment Equipment specification for the SDGH prepared by BDP in about November 1977 stated that the make-up water to each cooling tower should be from a treated water system and specified that the water treatment was required only to inhibit corrosion and prevent algal growth. The treatment was to be recommended by a specialist supplier using additives considered suitable in the light of the micro-organisms found to

be present in the system. The additives were to be introduced by an automatic dosing unit; the installation of an automatic drainage system controlled by a conductivity cell was also part of the specification.

182. Subsequently a contract was made between the RHA and water treatment specialists Houseman (Burnham) Limited ("Houseman"). Houseman installed automatic dosage pumps in the cooling towers at the SDGH which dosed the water cooling systems with Houseman biocides. The contract ended in March 1984. We received no evidence about Houseman's regime and accordingly make no comment about it.

183. On 17 January 1984 MSHA invited tenders for the provision of a water treatment service for the SDGH, the SGI and St George's Hospital, specifically including treatment of the SDGH air conditioning system, for the period 1 April 1984 to 31 March 1985. Fospur's tender was accepted by the RHA (as the contracting authority) but for a revised period, from May 1984 to 30 April 1985. Because of a desire to use up stocks of Houseman's products before those of Fospur were substituted, the contract period was subsequently extended to 31 May 1985.

The Contract

184. MSHA's tender specification included the requirement that "An experienced water treatment technician will visit each hospital on a monthly basis to carry out the necessary tests and make recommendations.... your recommendations as to the type of treatment required for each plant should specify any additional equipment required ie dosage pumps etc, and should also state the types of chemicals required...."

185. In response Fospur's tender specified the use of Kortokil 2020 and Kortokil 60 for the cooling tower water system, the amounts being "variable dependent upon bacterial count." The contract prices were fixed by reference to the cost for treatment of 1000 gallons (4546 litres) of water; there was no reference in the documents to the capacity of the system, but the make-up rate was said to be 355 gallons (1614 litres) per hour.

Protection Against Legionella

186. Although the contractual documents did not specifically refer to Legionella pneumophila, Mr Patrick Pickering, who remained Fospur's representative throughout the contract period, told us that MSHA asked him whether the recommended biocide was "effective against Legionnaires' Disease". He said without qualification that it was. He repeated the assertion at a meeting on 17 May 1984 called to establish a working relationship between Mr Pickering and the hospital engineers.

187. When on 12 November 1984 the hospital engineers drew his attention to claims made by Houseman that their biocide, LP5, was the only biocide found to be effective against Legionella pneumophila in field trials, Mr Pickering volunteered to test the cooling tower water system of cylinder 4 for Legionella at Fospur's expense, confidently expecting the results to be negative and thereby - as he noted at the time - "finish the competition." In the event the sample he took proved positive (see Chapter 4), but that merely caused Mr Pickering to decide on a temporary increase in the dosage of Kortokil 2020 after cleaning and chlorination of the cooling tower pond.

188. Until our Inquiry Mr Pickering consistently maintained the view that Kortokil 2020 was effective against Legionella, remaining loyal to his employers' claims based upon tests in the laboratory. In a press release of February 1984 Fospur had announced the launch of Kortokil 2020 as a new biocide "which, in addition to efficiently controlling the normal growth and slime problems associated with water systems, also efficiently kills Legionella bacteria." A further press release, in October 1984, asserted that Kortokil 2020 "has been shown in extensive trials to be totally effective in killing a broad range of organisms, including Legionella bacteria." We conclude that MSHA were sincerely encouraged by Fospur to believe that their biocide regime would have the advantage, incidental to its other purposes, of killing or at least inhibiting the growth of Legionella.

The Biocide Regime

189. From July 1984 onwards Mr Pickering, on behalf of Fospur, was entirely responsible for selecting the biocides for the SDGH's water treatment regime, instituting their regular dosage and inspecting and testing the water in the cooling tower ponds regularly thereafter. A crucial premise of Mr Pickering's policy, initially reflected in the terms of Fospur's tender, was that the regime could be altered as necessary in response to the results of the regular inspections and tests. At each of his monthly visits he checked the water system to ensure it was free from fungal growths, deposits of algae, bacterial slime and corrosion; he took a water sample for subsequent analysis; and he used a proprietary dip slide to measure the bacterial count. He also checked the levels of total dissolved solids (TDS) and the conductivity of the water. If the results were unsatisfactory he altered the dosages; if the TDS level was high he would initiate drainage and replenishment with fresh make-up water.

190. We have found no reason to fault that approach in so far as the general state of the water in the cylinder 4 cooling tower water system was not criticised in evidence, and the recurrence of high TDS and conductivity levels reflected a malfunction of the conductivity cell rather than the water treatment regime. However in relation to the Legionella contamination we think that it compounded Mr Pickering's mistaken assumption that Kortokil 2020 was effective, whether in killing the Legionella organism or inhibiting its multiplication. For Mr Pickering never appreciated that the efficacy of his biocide regime depended on the relationship between the biocide dosage and the design, of the cooling tower water system and the way in which it was operated, which were outside his knowledge and control. Consequently he believed, erroneously, not only that Kortokil 2020 was effective against Legionella, but also that its efficacy against Legionella could be adjusted by changes in the dosage following the results of his monthly visits. Inevitably these misplaced beliefs, which explained Mr Pickering's confidence in November 1984 (see paragraph 188 above), were communicated to and shared by the hospital engineers.

Biocide Dosage

191. Mr Pickering regarded the requirements of an effective water treatment programme as:-

i. the inhibition of scale deposits and corrosion;

ii. the prevention of the growth of bacterial slime, algae and fungi which would impair the efficacy of the water system.

192. To meet these requirements he devised a biocide dosage regime using Kortokil 2020 and Kortokil 60. To prevent the build-up of resistancein the bacteria he intended that the biocides should be used one at a time in 28-day, alternating, cycles.

193. For one cycle Mr Pickering specified that a stock tank should be filled with a mixture containing 7.5 litres of Kortokil 2020 for every 92.5 litres of water. The automatic dosing pump was to be set to "shot dose" the pond with this mixture at a rate of 3.5 litres an hour for 30 minutes every 3 days during a 28 day period. He believed that this would introduce 15 ppm every 3 days and a total in excess of 100 ppm in the 28-day period (see paragraph 179 above).

194. For the other cycle Mr Pickering specified that another stock tank should be filled with a mixture containing 2.5 litres of Kortokil 60, an alternative biocide with no claim to be effective against Legionella, for every 97.5 litres of water and "shot dosed" into the pond by the dosing pump at a rate of 3.5 litres an hour, this time for 45 minutes each 3 days in the next 28-day period.

195. In the event, the biocide dosage regime which was actually applied was quite different from that intended and specified by Mr Pickering, for the following reasons.

196. First, by the end of the public hearing it was established that the capacity of the cooling tower water system was 5110 litres (1124 gallons) - 3530 litres in the pond, and a further 1580 litres in the associated pipework. From the outset Mr Pickering had been wrongly informed that the system's capacity was 11,365 litres (2500 gallons) in total. As a result his calculations were based on the wrong information, which had been given

to him by the hospital engineers. The fact that it was wrong emerged late in our Inquiry, when Dr Brundrett requested that the capacity of the system be checked. It was then too late to investigate in depth the origin of the error, but our impression is that it did not originate with the hospital engineers.

197. Second, when Mr Pickering introduced his regime in about June 1984 he omitted to change the settings on the automatic dosing pump in the cylinder 4 cooling tower water system. As a result the dosage continued to reflect the wholly different requirements of Houseman's biocide regime. In the circumstances we see no advantage in seeking to calculate the dosage in fact achieved by Mr Pickering; but it is probable that the dosage of Kortokil 2020 was substantially less than he intended, that of Kortokil 60 substantially greater.

198. Third, Mr Pickering compounded the problem in January 1985 when, seeking to increase the dosage of Kortokil 2020 as a temporary response to the isolation of Legionella in the water sample taken on 12 November 1984, he underestimated it by a factor of 10.

199. Fourth, Mr Pickering treated the pond of cylinder 4's cooling tower water system with a casual "shot dose" of undiluted Kortokil 2020 on 30 April 1985, and might have done so on other occasions without recording the fact, with the result that the efficacy of the regime would in any event have been obscured.

Condition Of The Water

200. The state of the cooling tower water system could not reasonably be taken to reflect the efficacy (actual or intended) of the biocide regime in preventing growth of Legionella because this was affected by a number of other factors, such as the cleanliness of the system and its sterilisation with chlorine, which were entirely outside Mr Pickering's sphere of responsibility - and in the event did not accord with good practice as set out in HN(80)39 (see Part I of this Chapter). The water within the system was subjected to arbitrary and unpredictable drainage and replenishment and equally arbitrary absence of either. The hardness of the make-up water,

which in part reflected the questionable efficacy of the water softening plant, was another factor outside Mr Pickering's control. Nevertheless we have noted from Mr Pickering's regular reports the generally good state of the cooling tower water, although for the reasons expressed above we have no difficulty in accepting that it could at the same time have harboured Legionella pneumophila.

Conclusions

201. It has been shown that Legionella pneumophila was present in the cooling tower water system of cylinder 4 on at least two occasions, in November 1984 and in April 1985, despite the operation of a biocide regime, albeit an obscure one. The precise dosage of Kortokil 2020 achieved under this regime remains entirely a matter of conjecture but was probably too low to provide adequate protection against Legionella as judged by laboratory evidence.

202. We see no advantage in investigating this aspect of the matter further; for the purpose of Chapter 11 we assume that the biocide regime was ineffective and that the only potentially significant contribution to the story of the outbreak was the "shotdosing" of Kortokil 2020 on 30 April 1985.

CHAPTER 10: THE OUTBREAK FROM AN ENGINEERING VIEWPOINT

Identification of Source of Infection

203. The story of the outbreak as told from an engineering viewpoint is lengthy and involved. A starting point is the meeting convened by Dr Nnochiri on Wednesday 1 May 1985 and attended by Mr Miles, District Engineer, and Mr Rutter, Unit Engineer. There was a conflict in the evidence about the purpose and content of the meeting (similar to that discussed in Chapter 4, paragraph 64, in relation to the meeting on 30 January). According to the engineers, Mr Rutter had initially been invited by
Dr Nnochiri to bring with him the water sample reports obtained earlier in the year, because they were likely to be of interest to the newly-arrived CDSC team. Mr Miles accompanied Mr Rutter to the meeting, at which they handed over to Dr Nnochiri copies of the reports together with a copy of Mr Rutter's letter of 1 February concerning the revised programme for the treatment and cleaning of the hospital's cooling tower water systems (again see Chapter 4, paragraph 64).

204. According to Dr Nnochiri, when he learned of the results of the laboratory test which indicated that two of the patients had recently been infected with Legionella pneumophila (Chapter 4, paragraph 93) he had been inspired to take an interest in the procedures for maintenance, cleaning and chlorination of the cooling towers. It was to obtain information about this that he had invited Mr Rutter to come to see him. From the documents handed over by Mr Rutter, Dr Nnochiri was surprised to learn for the first time (as he would contend) of the earlier finding of Legionella in the hospital's cooling tower water system. Nevertheless he considered there was nothing to be gained from passing on this information to the Control Of Infection Committee as soon as possible, and indeed he did not do so until the special meeting on 3 May (Chapter 4, paragraph 104). On this issue we prefer to believe the evidence of the engineers because it seems more in line with the circumstances prevailing at that time.

205. In any event on the same day, Wednesday 1 May, following the meeting with Dr Nnochiri Mr Rutter contacted Mr Pickering of Fospur Limited and asked him ato visit the SDGH as a matter of urgency. Mr Pickering arrived early on 3 May and by 09.00 hrs had taken some water samples for analysis from the ponds of the hospital's cooling water systems.

Later the same day (Wednesday 1 May), after the Control of Infection Committee meeting, the engineers learned of the positive diagnosis of Legionnaires' Disease. At this stage it was still not known that the source of the infection was the hospital itself. Mr Miles and Mr Rutter again considered, as they had on the previous day, whether to chlorinate the cooling tower ponds but decided to await the outcome of the tests on the samples taken.

206. On Friday 3 May Mr Harper, an engineering scientist with considerable experience of Legionnaires' Disease, was told about the outbreak in Stafford during a phonecall with Dr Young, Deputy Director of CDSC. Mr Harper volunteered to help to identify its cause. Accordingly he travelled to Stafford and on Saturday 4 May Mr Harper met Dr O'Mahony and learned from her that the epidemiological evidence implicated the Out-Patient Department of the hospital itself.

207. In the afternoon of Saturday 4 May Mr Harper discussed the engineering plant and services with Mr Rutter, after which they took 24 water samples from the hospital's cooling tower water systems, domestic hot water calorifiers and various showers and taps, as well as from a pool of standing water on the roof. Appendix 8 lists the places where these and all subsequent samples were taken. Later that evening the samples were handed to Dr Farrell of Birmingham PHL who had travelled up to Stafford at the request of Dr Young of CDSC specifically to receive them.

Corrective Measures Taken

208. On the same day (Saturday 4 May), following a meeting at 19.00 hrs between Messrs Denne, Miles and Rutter, certain precautionary measures were agreed. Sodium hypochlorite was added to all the hospital's water systems, engineering and domestic (hot and cold) in amounts determined by Mr Harper to produce bacteriocidal concentrations, namely 5 parts per million (ppm) of free residual chlorine in the ponds of the cooling tower water systems and 1-2 ppm in the domestic water systems. The domestic hot water calorifiers were adjusted to raise the temperature at the outlet points to 63°C. Nursing staff were warned that the measures taken would create a strong smell of chlorine and increase the risk of scalding from hot taps; they were asked to ensure all staff were made aware of both. Late on Saturday night and early Sunday morning Mr Harper checked that the

levels of chlorine in the cooling tower water systems and domestic water systems were being maintained at the above levels of residual chlorine. He advised the health authority engineers to maintain the same levels for the time being and to check them regularly.

Samples Taken For Testing

209. On Sunday 5 May Messrs Harper, Miles and Rutter reviewed the possible causes of the outbreak (Appendix 9 lists all the test subsequently performed by the Health Authority engineers). Later that day Mr Denne and Mr Harper, together with Mr Bartlett and Dr Scully, met representatives of the Health and Safety Executive (HSE), who were informed of the measures taken so far to combat the outbreak. The HSE expressed themselves satisfied with the measures and with the treatment applied to the plant and water services.

210. On Monday 6 May Mr Rutter and Mr Henshall, witnessed by Messrs Harper, Denne and Miles, inspected the ground floor OPD air conditioning plant ductwork. Samples were taken by means of swabs moistened with distilled water and were sent for analysis to Birmingham PHL. On the same day, a start was made on removing all the spray tap fittings beginning with those in the OPD, the purpose of this action being to eliminate any risk of aerosol generation by the sprays. That day a meeting was also held between Health Authority staff including Messrs Denne, Miles, and Rutter, Mr Harper and representatives of Fospur Limited and Boots Biocides Limited to discuss the previous finding of Legionella in cylinder 4's cooling tower water system and the precautionary measures recently taken. Mr Harper advised the Health Authority engineers that it would be safe to bring the cooling towers and refrigeration plant back into operation, but Mr Denne and Mr Miles decided to await the results of the tests on the environmental samples before doing so.

211. In the days that followed, the Health Authority staff took a number of samples from the other Stafford hospitals and despatched them to Birmingham PHL for analysis. A programme of chlorination was also carried out at those hospitals.

212. On Thursday 16 May the Health Authority was informed by Birmingham PHL that all the environmental samples so far taken from the SDGH were negative for Legionella. There had been positive results from samples taken from the other hospitals, but given the ubiquity of the organism this was not considered surprising; and in any event the isolates were subsequently (on 6 June) shown to belong to a strain different from the epidemic strain.

213. On 16 May a microbiologist from the Centre for Applied Microbiology and Research (CAMR) visited the SDGH to undertake further environmental sampling including the air in the OPD. At the same time samples were taken from the drain traps of the chiller batteries and sections of the automatic roll filters of the cylinder 4 air conditioning plants. Dr Hutchison, Director of Birmingham PHL, visited Stafford on 16 May, and took the samples of water taken on 4 May by Mr Harper from the ponds of the four cooling tower water systems to the City of Birmingham Environmental Health Department in order to find out whether they contained traces of Kortokil 60 or Kortokil 2020. The samples were subsequently passed to CAMR to be analysed by gas-liquid chromatography for fatty acid profiles consistent with the presence of dead Legionella organisms. On 16 or 17 May the hospital engineers injected sodium hypochlorite into the OPD chiller battery condensate trays.

214. On Friday 17 May, at a meeting with representatives of Fospur Ltd at which Mr Bartlett was present, Mr Denne learned that Boots Biocides Ltd had found Legionella in low concentration in the water sample taken by Mr Pickering from the pond of cylinder 4's water system on 3 May. The finding was formally confirmed by Boots Biocides Ltd in a report dated 21 May.

Consideration of Means of Dissemination

215. In the light of this finding Messrs Denne, Miles and Rutter began a search for the means by which the organism now shown to have been present in the pond of the cooling tower water system could have infected patients visiting the OPD. Tracing the drainage stack (see figure 12) down from the cooling tower pond to the underground plant drain they discovered that the connection into it from the OPD chiller battery condensate tray drain was not "swept in": indeed, the two pipes met at right angles. Following the chiller battery drain away from the vertical drainage stack back towards the chiller battery, the hospital engineers not only noticed an apparent lack of fall in the drain pipe but also became aware of the absence of an airbreak anywhere in this drain system. These factors led them to concentrate their investigations on this part of the OPD air conditioning plant, and to speculate whether these factors could point to a possible route for contamination.

disseminated from the pond of cylinder 4's cooling tower water system. According to this theory, once the cooling tower water system pond had been colonised by the organism, contaminated water from the pond passing down the vertical drainage stack could have flowed back from the stack along the OPD chiller battery drain and so have contaminated the OPD chiller battery itself. On 29 May Mr Denne made a video recording of an experiment devised to illustrate this theory, for which purpose a clear glass U trap of equivalent dimensions was fitted in place of the normal copper U trap in the drain under the chiller battery drip tray.

220. The video concentrated on this glass U trap, which for the purposes of the experiment was first fully filled with water. The drain pipes from the chiller batteries of the air conditioning plants on the other floors served by cylinder 4 were disconnected and the connections into the vertical drainage stack plugged (. figure 12). The OPD air conditioning plant was set to work normally with its fan on. Water from the pond of the cooling tower water system was then discharged through the one-inch diameter manual drain into the vertical stack. The water in the U trap was seem to oscillate as a result of the differing and contrary air pressures exerted on it.

221. The Health Authority engineers then drained the glass U trap and refilled it with 350 ml of water, a quantity equal to that found in it when it was first examined and insufficient to provide a proper seal in the U trap. Then the OPD air conditioning fan was switched off and water was discharged down the vertical stack as before. Air was seen to be bubbling through the water in the trap in the direction of the chiller battery abd water droplets were blown up towards the base of the chiller battery.

222. When no water from the cooling tower system was discharging down the vertical drainage stack and the OPD air conditioning fan was running, the video showed that air bubbled through the water in the trap and droplets of water were blown out of it in the direction of the vertical drainage stack. When the engineers disconnected the glass U trap and water was again discharged down the vertical drainage stack, it was found to run back along the drain towards the chiller battery. When the trap was refitted to the drain it began to refill with this water running back from the stack. The water quickly reached a level where bubbling occurred and the water droplets were blown back towards the underside of the chiller battery.

223. Having satisfied themselves by these experiments that it was possible for the chiller battery to have become contaminated with Legionella from the cooling tower pond, the engineers next considered the potential for its consequent multiplication and dissemination. They noticed that when the OPD air conditioning fan was switched off, the associated isolating damper did not close completely (a modification deliberately made during the defect liability period when problems were encountered with starting up the fan if the damper was fully closed). Therefore, they reasoned, during the periods when the OPD air conditioning fan was not running, the fans on the first and second floors could draw air not only downwards out of the fresh air inlet duct, but also upwards out of the OPD through its air conditioning plant. The engineers' argument was that once the chiller battery had been contaminated in the way described above, the water containing the Legionella would be exposed to warm air drawn out of the OPD during the periods when the OPD fan was off - that is, between 17.00 hours one day and 0900 hours the next - and thus the Legionella would be enabled to multiply.

224. They also noticed that the OPD chiller battery lacked a baffle plate and an angle deflector. Therefore they thought that when the OPD air conditioning fan was restarted, air would be drawn underneath the main chiller coil and across the surface of the condensate drip tray. They considered that in doing so it could aerosolise any contaminated water in the condensate tray and carry it into the OPD, but they did not attempt to demonstrate this possibility.

Some Samples Prove Positive

225. On 6 June 1985 Dr Scully was informed by Dr Farrell that Legionella pneumophila had been recovered from the sample of Densofil taken on 21 May. On the same day Mr Dennis of CAMR report to Dr Farrell that subtyping of the Legionella pneumophila previously isolated had shown that the strains recovered from infected patients were of the same subtype (Pontiac 1a) as was found in the sample of Densofil and in the water sample taken by Mr Pickering on 3 May from cylinder 4's cooling tower water system. In consequence on 8 June all Densofil was removed from the chiller battery serving the OPD air conditioning plant, and tested for Legionella by Birmingham PHL. None was positive for Legionella.

226. On 13 June Mr Waite of CAMR reported that using the gas-liquid chromatography method he had found fatty acids consistent with the presence of Legionella pneumophila in two samples those from the main drip tray and the end drip tray of the OPD chiller battery. These findings together with those from the pond of cylinder 4's cooling tower water system and from the Densofil on the OPD chiller battery remain the only positive findings of Legionella at the SDGH around the time of the outbreak.

The Drains

227. When developing the backflow theory the engineers considered the possible reasons why the air pressure of four-inches water gauge should have occurred in the vertical drainage stack when water was flowing down it from the cooling tower pond via the one-inch manual drain. They concluded that the most likely reason was a partial blockage somewhere in the plant drainage system which would have prevented water draining away quickly.

228. Therefore on 13 June the Health Authority engineers discharged a large quantity of water (the contents of the high level water storage tanks) down the cylinder 4 vertical plant drainage stack to flush through the drainage system. At the time the manometer was again connected to the vertical drainage stack side of the chiller battery drain pipe. As the water passed down the stack noises were heard as of stones or similar objects rattling down and the manometer reading oscillated markedly - up to 20 inches water gauge difference. When the flow of this large quantity of water had stopped, the one-inch manual drain from the cooling tower pond was opened again and the pressure in the vertical drainage stack was found to be 0.5-inch water gauge, compared with the four-inch water gauge observed prior to the operation. It appeared the release of such a large volume of water had cleared an obstruction in the plant drainage system,and it was thought possible that the cause of the air pressure in the stack which - according to the backflow theory - had blown contaminated water into the chiller battery had been removed. Attempts were made the following day to ensure no blockage remained by rodding the main underground plant drain, but this proved difficult because of the scarcity of access points and the configuration of the drainage system. On 17 June a television camera was inserted into the main horizontal underground drain, and passed through much of the drainage system; a recording was made, which we saw. A certain amount of silt was found in the underground drain, but otherwise the drain was clear. We were, however, shown articles taken from the underground drain sump, which included half a copper sphere, a tape measure and a contractors' lightbulb.

No Alternative Theory Considered

229. Mr Harper and the hospital engineers spent a considerable time investigating the various elements of the backflow theory, which they were convinced accounted for the outbreak. Probably for that reason they spent little time investigating any alternative theory, although previous outbreaks of Legionnaires' Disease in some hospitals had been attributed to the carryover of contaminated aerosols expelled from wet cooling towers being drawn into a building so as to infect patients.

Air Conditioning Plant Returned to Service

230. On 4 July, when the whether became much warmer, the air conditioning systems and cooling tower of cylinder 4 were brought back into operation, except only for the air conditioning unit serving the OPD. Further tests were conducted on this unit on 5 July, and that night it was switched on and left running 24 hours a day. This was the position when we started our Inquiry on 9 July.

231. During our hearing in October we received from MSHA a statement (reproduced at Appendix 10) of the controls they proposed to introduce at the SDGH to minimise the risk of any future outbreak of Legionnaires' Disease at the hospital. Subsequently, in January this year, we have been notified of MSHA's intention to replace the water cooling tower systems at the SDGH with air-cooled systems. We are satisfied that the measures taken and planned will minimise the risk of any future outbreak.

D28/J05/AB

CHAPTER 11: CAUSE OF THE OUTBREAK

Introduction

232. The epidemiological evidence summarised in Chapter 5, paragraph 119, established the duration and location of the outbreak of Legionnaires' Disease at the SDGH. It has been shown that the period during which the outbreak occurred was from 9 to 19 April 1985, and that it involved those parts of the SDGH served by the cylinder 4 air conditioning systems. In the light of this knowledge we have sought to establish the cause of the outbreak at the hospital.

Summary

233. From the evidence put before us we are now satisfied that the water system in the cylinder 4 cooling tower became heavily contaminated with Legionella pneumophila, serogroup Pontiac 1A, a strain virulent for man. This contamination had reached a significant level by Tuesday 9 April, the end of the Easter weekend. Certain factors relating to the mode of operation of the cooling tower and the condition of its water system contributed to the organism's multiplication and dissemination. We believe that from 9 to 19 April the organism was disseminated in concentrations sufficient to cause severe infection by means of an aerosol created in the cooling tower. This aerosol entered the cylinder 4 fresh air inlet duct serving principally the maternity unit on the second floor, the operating theatres on the first floor and the OPD on the ground floor. From this duct the aerosol passed through the air conditioning plant on each floor and was inhaled by the patients, the visitors and staff. The infection was most severe among the particularly vulnerable persons attending the out-patient clinics.

234 We are satisfied that the OPD chiller battery insulant and two of the associated condensate drip trays became contaminated with Legionella pneumophila. From the evidence we cannot say when or how such contamination occurred. We doubt whether it was possible for the organism to be disseminated from this chiller battery or trays so as to reach the departments concerned. However we are satisfied that on any view the effects of this further contamination, including any possible onward dissemination, were probably of secondary importance to the means of multiplication and dissemination referred to above.

235 In addition to the route of dissemination described in paragraph 233 above we think it possible that contaminated aerosols were also carried from the cylinder 4 cooling tower down the outside of the building so as to be a potential source of infection to any person outside but in the immediate vicinity of the hospital, or to a person inside but close to an open window. This would explain how a few individuals were infected who apparently were not directly exposed to the cylinder 4 air conditioning systems.

236. We have considered the possibility of other sites of contamination, such as domestic water systems, and of other means of dissemination, such as showerheads, spray taps, or leaks from heaters in the air conditioning ductwork. We have heard no evidence to suggest that any of these played any part in the outbreak.

237. We are satisfied that dissemination of Legionella pneumophila in concentrations capable of causing severe infection ended on or about 19 April 1985 for reasons which remain unclear. Contamination of the cooling tower water system may have remained at a substantial level for longer, but was shown to have become barely detectable by 3 May 1985.

The Operation Of The Cylinder 4 Cooling Tower

238. In Chapter 8 we set out the general principles of cooling tower operation. We now discuss the particular modes of operation of the cylinder 4 cooling tower and how these modes were conducive to the multiplication and dissemination of Legionella pneumophila. The operating modes were established by our expert advisers acting in conjunction with the Health Authority engineers (See Appendix 11).

239. The function of the cooling tower water system is to remove the heat extracted by the refrigeration unit from the chilled water circuit (See Chapter 8, figure 8). The system is illustrated diagrammatically in figure 13 opposite.

240. A pump (A) operates continuously to drive water through the refrigeration unit (B) where it removes heat, and around the recirculating pipework loop (coloured red in the diagram) back to the pump (A). As the water removes heat from the refrigeration unit, its temperature rises. The temperature of this water is measured by a sensor (C) located at the water inlet to the refrigeration unit, which is linked to a control mechanism (D) which in turn governs the operation of the three-way valve (E).

241. The purpose of the three-way valve is to provide for further cooling of the water, when required, by diverting a proportion of the circulating water from the recirculating loop into the upper part of the circuit (coloured blue in the diagram) and so to the top of the cooling tower. There it is sprayed downwards over the tower packing, cooled by the air being drawn upwards through the tower by the fan (F), and drains into the cooling tower pond (G).

242. According to the design intent, when the water temperature reached the preset level of 26°C, the sensor would activate the three-way valve so as to close progressively port E2 on the recirculating loop and open port E1 on the cooling tower loop. By this means a proportion of the water flowing around the recirculating loop would be diverted to the top of the cooling tower, and some cooler water from the pond would pass through port E1 to mix with the remaining water passing through port E2, so as to maintain a temperature of 26°C at the sensor. A further aspect of the design intent was that as soon as the three-way valve was brought into operation and port E2 began to close, an electrical circuit would activate the fan at the top of the tower, so ensuring that this fan was operating at all times when water was being sprayed into the tower.

243. As the three-way valve was activated and port E2 began to close to divert water to the top of the cooling tower, it was necessary that the water pressure in the recirculating loop should increase sufficiently to force such water to the top of the tower. In order to balance the pressures in the two loops (recirculation and tower, marked red and blue on the diagram), the design specified the fitting of a flow restriction (pressure regulating) valve (H) in the recirculating loop.

244. In the event, we heard in evidence that the cooling tower as constructed differed from this design intent in certain respects. First, in the cylinder 4 cooling tower water system, instead of a flow restriction valve in the recirculating loop a standard gate valve was fitted. The hospital engineers stated that under normal operating conditions this valve was always left in the fully open position. As a result, the flow of water to the three-way valve was not restricted in the way intended by the designers, and accordingly the pressure in the recirculating loop was not balanced with that in the cooling tower loop. Further, our expert advisers together with the hospital engineers were able to demonstrate that this lack of pressure balancing, in conjunction with the low pressure drop across the three-way valve at full flow, resulted in the three-way valve

not operating as intended. Their experiments showed that the valve had to move to between seven and eight tenths of its full travel before water was diverted from the recirculating loop to the cooling tower loop. Then the diversion was sudden, and the quantity of diverted water substantial. Consequently, the flow of much cooler water from the cooling tower pond through port E1, now nearly fully open, increased markedly. The resulting rapid fall (to below 26°C) in the temperature of the water entering the refrigeration unit caused the sensor to signal to the three-way valve to start moving in the opposite direction so as to open port E2. Quite rapidly the point was reached where the flow of water to the top of the cooling tower almost ceased, and once again almost all the water was being pumped around the recirculating loop. This cycle of events was then repeated.

245. A further important facet of the operation of the three-way valve was that its control mechanism contained a "proportional band" of 10°C, such that the valve moved progressively from fully open to fully closed when the temperature measured by the sensor increased from the preset point of 26°C to 36°C.

246. The overall effect of the lack of hydraulic balance in the recirculating loop, taken with the other factors described above, was that the cooling tower water system operated in a cyclical fashion (see figure 14), resulting in periods when the temperature of the water in the recirculating loop rose above 30°C interspersed with periods when this water was diverted to the cooling tower and rapidly cooled.

The Steady Shower And The Three-Inch Gap

247. Two further features related to the cooling tower became apparent during one of our site visits, which later assumed significance (see paragraph 254). First, we observed that a steady shower of water fell continuously through the cooling tower packing into the pond, whether the cooling tower fan was on or off, though the reasons for it were not satisfactorily explained.

248. Second, it was down to our attention that the floor of the cooling tower section of cylinder 4 did not extend to the wall so that the air inlet for the cooling tower and the fresh air inlet for the air conditioning systems were not separate. The gap was approximately three inches wide (figure 15). This raised the possibility that air from the cooling tower plant room could be drawn into the main air inlet duct of the air conditioning systems.

Contamination And Multiplication

249. The water samples taken from the pond of cylinder 4's cooling tower water system on 12 November 1984 and 3 May 1985 were both found to contain Legionella pneumophila serogroup Pontiac 1A, the strain subsequently isolated from the patients. After receiving the results of the November 1984 sampling in January 1985, the hospital engineers took prompt action in thoroughly cleaning and chlorinating the system. Without impugning their efforts, we do not think that they succeeded in eradicating the organism completely from the water system. Although it is possible the system was contaminated on a second occasion independently of the first, it seems unlikely. We note the complexities of the cylinder 4 system's construction (related to its providing air conditioning for the most important areas of the hospital), and we doubt whether it was possible to do more than reduce substantially the initial level of contamination to the point at which a water sample taken on 28 January 1985 proved negative. When subsequently the water condition changed, the organism flourished again. Moreover, at all material times until the 30th April 1985, and with the exception of a short period following the chlorination in January 1985, we consider that the cooling tower water system of cylinder 4 was not subject to an effective biocide regime (see chapter 9).

250. Whenever it occurred, contamination of the pond probably arose naturally by transmission of the organism through the atmosphere. England et al* suggested a possible relationship between contamination and ground disturbance, and we note that there had been earth-moving on the hospital site throughout the material time.

251. Once the cylinder 4 cooling tower water system was contaminated, its operating modes (described above) provided temperatures suitable for the multiplication of Legionella pneumophila. The evidence indicates that prior to the critical period of 9 to 19 April 1985 the cooling tower in cylinder 4 was probably required to provide a small though regular amount of cooling. During the periods (see paragraph 246) when the water temperature in the recirculating pipework loop gradually increased up to about 33°C, conditions were favourable for Legionella

* Sporadic Legionellosis in the United State: The First Thousand Cases (Annals of Internal Medicine Vol 94, Feb 1981, p.166)

pneumophila to multiply. In the periods when water was diverted to the cooling tower the organism would be transferred to the cooling tower pack and pond, where the temperature would be sufficient for it to survive comfortably. In this way a significant concentration of Legionella pneumophila could have been built up in the cooling tower water system over a period of time.

252. In this context we have noted in an article by J B Kurtz et al* that "A significant association was found between Legionella infection and the concentration of chlorides and total dissolved solids, and a raised pH" in a water system. The article made the point that the build-up of chlorides and total dissolved solids indicated inadequate 'bleeding' of the water system. This lack of replacement with fresh water could play an important part in contributing to the build-up of contamination with Legionella pneumophila.Consequently we have attached importance to the results of Mr Pickering's routine tests of the cylinder 4 cooling tower water system during his visits in March, April and May 1985, in the light of his assessment that a desired control level for total dissolved solids would be about 2000 ppm:-

	22 March	30 April	3 May
Total Dissolved Solids(ppm)	2975	5600	1302
Conductivity (microsiemens)	4250	8000	1860
pH	8.88	No measurement	9.2

253. We are satisfied that the high readings in March 1985 and the marked increases in April 1985 reflected a period of inadequate drainage and replenishment of the water system which in turn could have been conducive to the multiplication of Legionella pneumophila. Mr Pickering was concerned at the levels recorded on 30 April: he discovered that the conductivity cell had been rendered inoperative, apparently to stop a leak from it. The cell should have sensed the rising level of conductivity of the water and automatically instituted drainage, with the consequent replenishment with fresh make-up water. We agreed with Mr Pickering's supposition that the cell had been out of action for some weeks prior to his visit on 30 April 1985. The hospital engineers accepted that the cell had been out of action, but were unable to say for how long.

* Legionella pneumophila in cooling water systems, J. Hyg 1982, 88, 369-380

Dissemination Of Contaminated Aerosols Generated In The Cooling Tower

254. Given contamination of the cooling tower water system, the creation of infected aerosols was inevitable whenever water was spraying down into the pond, irrespective of the prevailing mode of operation of the cooling tower. We have already noted that water sprayed down the tower continuously, in amounts which varied from a shower (see paragraph 247) to the full flow.

255. We turn to the alternative routes by which an aerosol from the tower could have reached those parts of the hospital where patients and staff were infected. In evaluating the evidence put before us we have been influenced by the results of the tests carried out for our expert advisers by Dr D J Dickson of the Electricity Council Research Centre using a tracer gas, sulphur hexafluoride.

256. On 13 September 1985, with a westerly wind measured at 3 metres/second, and subsequently on 23 September 1985, with a northwesterly wind measured at 4 metres/second, tracer gas was released in the cooling tower. These conditions were comparable to those prevailing during the period of the outbreak. The concentrations of the gas subsequently found at particular points in the hospital were measured by a detector chromatograph. The tests were carried out with the cooling tower operating in each of its different modes. Figures 16 (a) and (b) opposite illustrate these two modes.

257. On 23 September 1985, the tests carried out on 13 September were repeated using a larger quantity of gas to give increased sensitivity. The detector chromatograph's sampling tube was then placed in the vertical fresh air inlet duct, 0.9 metres below the level of the rooftop plant room floor and gas released from a cylinder placed on the top of the air inlet louvres at the base of the cooling tower. When the cooling tower fan was operating and water was spraying down the tower, about 0.1 per cent of the tracer gas was detected in the fresh air inlet duct. A quarter of this concentration was found when the fan was on with only the steady shower falling down the tower. But when the same test was repeated with the cooling tower fan off, regardless of how much water was falling down the tower, the concentration of gas detected in the fresh air inlet duct was increased more than one hundred fold.

258. The detector chromatograph was taken to the ground floor areas served by cylinder 4, where the concentration of gas in the air was measured at six different points (a naturally ventilated room and an air conditioned waiting area, and the courtyards which they overlooked; and at two places in the "Harness" street). The measurements showed that the sulphur hexafluoride gas detected in the vertical fresh air inlet duct reached both the air conditioned and naturally ventilated parts of the OPD at the same concentration as found in the inlet duct. In the courtyards the air was found to be 3.5 times more contaminated than the air passing along the ducts.

259. From those results we are satisfied that an aerosol disseminated from the cooling tower when operating in either mode (that is, either by being expelled with the air from the top of the tower and then drawn from the outside through the air inlet grille; or by being drawn across the cooling tower plant room through the steady shower of water in the tower and passing through the three inch gap in the floor) could have reached the vertical air inlet duct.

Dissemination: The Backflow Theory

260. In Chapter 10, we described the research carried out by the hospital engineers which led to the "backflow theory". Briefly, this postulated that the cylinder 4 cooling tower water system had become contaminated with Legionella pneumophila as previously described. When the water system was drained via the same vertical drainage stack which also drained the condensate water from the OPD chiller battery, contaminated water from the cooling tower water system could flow back along the chiller battery drain and through the trap so as to contaminate the accessible parts of the OPD chiller battery.

261. According to this theory, because the air conditioning system to the unoccupied OPD was switched off at night from 31 March 1985 onwards and the associated isolating damper was not fully closed, warm air from the OPD was able to flow backwards along the ductwork over the chiller battery and drip trays, thus sufficiently raising the temperature of any contaminated water present to the point where Legionella pneumophila could multiply. When the air conditioning fan was again switched on the following morning, it was argued that aerosolisation of the contaminated water on the chiller battery and in its trays occurred.

262. The demonstration of Legionella pneumophila in the OPD chiller battery drip trays and insulant, the failure to fit the same battery with a baffle plate and an angle deflector, and the apparent confining of the infection to patients exposed in the OPD (prior to full epidemiological evidence becoming available), led us to spend considerable time on assessing the potential of the OPD chiller battery and its drip trays as the prime cause of the outbreak. For the reasons which follow we have concluded that no such potential was demonstrated.

263. First, the contamination of the chiller battery drip trays and insulant could have arisen by the passage of air contaminated with Legionella pneumophila through the chiller battery. The rapid accumulation of silt in the glass U trap fitted after the outbreak to the chiller battery's main drip tray served to demonstrate that the battery could "scrub" particles out of the air passing through it. We can envisage Legionella pneumophila suspended in the air being trapped in this way.

264. Second, we doubt whether a sufficient quantity of infectious aerosols could have been generated from those areas. The air velocity through the chiller battery and across the water lying in its drip trays (or on the floor of the duct, where we were told there was evidence that water had been present at some time) was insufficient to drive droplets off the relevant surfaces. If any aerosol were generated there, we accept that when the OPD fan was off the constant operation of the fan in the first floor air conditioning plant serving the operating theatres would draw air from the chiller battery into the fresh air inlet duct and up to the first floor. We cannot accept that any aerosol drawn up to the first floor level could resist the pull of this first floor fan in favour of that of the the second floor fan so as to be drawn up to that level and infect staff working there.

265. Third, we doubt whether the temperature of the chiller battery and its associated drip trays could have been sustained at a level sufficient to enable Legionella pneumophila to multiply substantially. When the OPD air conditioning system was not operating and the first floor air conditioning fan drew warm air back from the OPD, the OPD chiller battery (which was not affected by the time clock) would have been activated by its associated temperature sensor and so its temperature would have been reduced.

266. Fourth, the marked bubbling in the U trap underneath the chiller battery's main drip tray, which was demonstrated in the hospital engineers' video recording, and any associated aerosol generation reflected a specific combination of circumstances (see chapter 10, paragraphs 219-224). One such factor was a substantial rate of flow of water down the main vertical drainage stack. There was no evidence that such a flow occurred at the material time, quite the reverse: the manual drain valve was closed and there was no evidence to suggest that the lesser flow rate generated by the operation of the automatic drain or of the pond's overflow would suffice. Indeed, it appeared to have been a feature of the outbreak (see paragraph 253) that the drainage from the pond was minimal over the whole of the relevant period.

267. Fifth, it does not in any event seem possible that the aerosolisation of water in the drain trap could have been the direct source of the aerosol which infected patients. An experiment conducted by Dr J Lee and his colleagues from CAMR demonstrated that water droplets could be generated from the trap in the following specific circumstances:-

a. when the OPD's air conditioning fan was coming to a stop (which would have happened at 17.00 hours each day from about 1 April 1985 onwards);

b. when there was an air pressure of 4 inches water gauge in the vertical drainage stack (which we were told, only occurred when water was discharging down the one-inch diameter manual drain from the cooling tower pond); and

c. when there was a critical volume of water in the trap.

In such circumstances measurable quantities of aerosol were shown to enter the ductwork until a few minutes after the fan came to rest. However, once the fan had stopped, the reverse air flow (described in paragraph 261 above) would carry this aerosol up to the first floor.

268. We were told in evidence that an aerosol might possibly have been generated during the periods when the OPD fan was running, but in an amount too small to be detected within the limits of the experiment, and therefore almost certainly insufficient to cause infection on a major scale over a prolonged period among the people attending to OPD. We had no evidence that these specific circumstances occurred regularly - rather the

reverse; the absence of water discharging down the manual drain appears to have been a feature during the outbreak period, and it seems unlikely that the volume of water in the drain trap would consistently have been replenished to the critical level for any appreciable time.

269. The absence of evidence supporting the multiplication of Legionella pneumophila in the chiller battery or its dissemination from it during the outbreak leads us to the view that neither the chiller battery itself nor its associated drainage pipework could have been a significant contributory factor in causing the outbreak.

The Timetable Of The Outbreak: Onset

270. Having discussed the probable means of contamination and dissemination, we now consider the onset and termination of the outbreak. The epidemiological evidence provides the timescale: dissemination of Legionella pneumophila in quantities sufficient to cause numerous infection began on 9 April 1985 and ceased on or about 19 April 1985. Whatever the state of the cooling tower water system after 19 April, there was a minimal contamination by 3 May 1985 when the water sample was taken.

271. We have been unable to explain the inception of this dissemination on 9 April, although we have noted two possibly relevant factors. First, there was a marked rise in external air temperature immediately preceding this period of dissemination (from 5.8°C on 27 March to 14°C on 30 March) and a relatively high temperature persisted throughout the critical period. This rise in temperature could have been significant, because it may have demanded greater cooling and, thus, increased activity of the cooling tower.

272. Second, over the period of the outbreak there was a high level of relative humidity. In conditions of very high humidity the rate at which droplets evaporate is reduced and their life as droplets prolonged. However, the importance of high relative humidity is that it increases the activity of the cooling tower rather than prolongs the survival of the droplets or any contained mirco-organisms. In fact there is evidence that mirco-organisims often survive better at lower levels of humidity. The process of the generation of an aerosol depends on the activity of the cooling tower, and under conditions of high relative humidity this activity has to continue for longer than isnecessary in a dry atmosphere in order to achieve the same degree of cooling.

The Termination

273. The termination of this period of dissemination is not easily explained. The evidence disclosed nothing to suggest that contamination stopped at about 19 April, although we noted one possibility raised in the evidence of Dr Lee of CAMR. He told us that research into the life cycle of other bacteria similarly found in water had demonstrated that they could be reduced in number, suddenly and drastically. The reasons for this phenomenon remain obscure: one possibility was a substantial fall in temperature. We have noted that in Stafford such a fall did occur between 18 April and 20 April, from 16.5°C to 8°C. We considered it possible that dissemination ceased at this time, again as a consequence of the fall in temperature, with contamination persisting until the events described below.

274. Any contamination of the cylinder 4 cooling tower water system continuing after 19 April must have been substantially reduced on or immediately after 30 April 1985. During his visit on that day, Mr Pickering (of Fospur) casually "shot dosed" the pond with 2 litres of undiluted Kortokil 2020 that were surplus to the requirements of other towers which he had been visiting that day.

275. Again during the same visit, noting the unusually high level of conductivity of this water system, Mr Pickering caused the hospital engineers to re-institute automatic drainage and replenishment. As a result, on 3 May the readings for conductivity and total dissolved solids were substantially reduced (see paragraph 252); and the sample of water then taken was found to contain only a minimal concentration of Legionella pneumophila. Essentially the state of the water had been so drastically altered that any persisting contamination had been radically reduced.

Conclusion

276. In this chapter we have sought to explain how the cooling tower water system of cylinder 4 became contaminated with Legionella pneumophila, and how the organism could have multiplied within the system. We have also set out our arguments for rejecting the backflow theory as the primary route of dissemination in favour of the dissemination by means of the main fresh air inlet duct of a contaminated aerosol, created in the cooling tower. Further, we have discussed the possible reasons for the onset and termination of contamination of the water system and dissemination from it of a highly infectious aerosol.

277. Within the context of a public Inquiry we consider we have gone as deeply as we have been able in fulfilling the first part of our terms of reference. In our view, there are certain aspects of infection with Legionella pneumophila which are not fully understood, and this must remain the case until further research is mounted into the ecology of the organism. In part two of our Inquiry we will be looking closely at the need for such research (see Chapter 1, paragraph 6) and we will return to this when we make our final recommendations at the end of part two of our Inquiry.

CHAPTER 12

COMMENT ON ENGINEERING ASPECTS

Design and Construction

278. We preface our comments upon the design of the SDGH by BDP, as architects and engineers, with two provisos. First, our inquiry only required us to look at one aspect of a necessarily complex and substantial structure: we do not, indeed cannot, comment on the design as a whole except to record the admirable impression made upon the visitor. Second, we are conscious of the time-scale involved and the danger of unfair comment based upon hindsight. These provisons confine our inital comment to the following.

279. When in March 1981 the CIBS emphasised the importance of siting fresh air inlets away from and downwind of cooling towers (see Chapter 7, paragraph 149), we note the apparent failure to review the proximity of these features in the SDGH design. However we achknowledge that construction was by that date well advanced and it may not have been feasible to make any adequate modification.

280. With the benefit of hindsight, we question whether it can now be regarded as safe to utilise water cooling towers in conjunction with hospital air conditioning systems, for two reasons. First, there are inevitably a number of persons within hospital who, by virtue of their age and state of health are peculiarly vulnerable to infection by Legionella pneumophila; that puts a premium upon hospital design which as fas as possible eliminates opportunities for the multiplication of this organism. Second, we had much evidence that served to demonstrate how the efforts of conscientious hospital engineers to operate and maintain one such cooling tower water system were on two occasions unsuccessful. Their difficulties and failure reflected the demands put upon them respectively by this sophisticated plant and the ubiquity of this organism. It would be an exceptionally knowledgeable operational engineer who could run the former so as to be confident of keeping it free from the latter. The experience gained at Stafford should enable the SDGH's cooling tower water systems to be operated safely, although we note with approval the imminent replacement of cylinder 4's cooling tower with an air-cooled condenser, and the programme for the future replacement of the others as resources become available.

281. Again we comment on certain specific features of any cooling tower water system which might serve to increase the potential for an outbreak of Legionnaires' disease. These comments are reflected in Recommendation 8. One aspect of the Recommendation calls for further comment. We established that the air conditioning plant serving the operating theatres relied upon cylinder 4's cooling tower only, with the result that the hospital engineers were prevented from taking the tower out of operation for thorough maintenance (see paragraph 62 in Chapter 4). We think that comment on this aspect of the design can only be made with hindsight: it is only in the light of knowledge now available that the importance of regular, thorough and therefore prolonged cleaning of cooling tower water systems has been established, even if the use of operating theatres and other essential services must be interrupted as a consequence.

282. In hospitals the use of water-cooled or air-cooled air conditioning systems, bringing with them their particular operational and financial problems, reflects increasing and (as in the case of the SDGH) substantial reliance upon air conditioning. In our view, hospital designs which require extensive air conditioning should be reviewed: See Recommendation 6. Where air conditioning is included in the design of future hospitals, it shoud not incorporate wet cooling tower systems (Recommendation 7).

283. We inquired at considerable length into other relevant aspects of the SDGH's detailed design and construction and noted the following deficiencies:-

a. the three-inch gap between the edge of the upper plant room floor and the air inlet grille;

b. the lack of air breaks between the cylinder 4 vertical drainage stack and the connecting drains from the chiller battery trays;

c. an inadequate fall on the drain from the OPD chiller battery tray to the vertical drainage stack;

d. partial blockages of the cooling tower drainage system in cylinder 4;

e. the failure to fit a baffle plate and deflector to the OPD chiller battery;

f. the alteration of the damper in the OPD air conditioning duct to prevent it from closing fully; and

g. the poor connections between the end and main drip trays of the OPD chiller battery and their associated drain pipes.

284. We have examined in Chapters 10 and 11 the extent to which any of these features were relevant to the outbreak. Recommendation 17 follows. Here we comment that detailed design and construction features such as these do have an importance in the context of eliminating cross infection. Indeed we urge that more attention be paid to the potential risk of cross infection during the detailed design, construction and commissioning (see paragraph 288 below) of hospitals, particularly in view of the available knowledge that infection can be propagated by way of an aerosol. In this context we find no sensible distinction between foul and other drain stacks; we consider air breaks and water traps to be particularly valuable impediments to cross infection and in the case of the latter we recommend that they should be designed to be easily checked visually for the presence of an effective water seal.

285. Recommendation 17(c) reflects our concern that certain features of a chiller battery, namely the 'air scrubbing' characteristic, and of its drip trays, namely the occasional accumulation of substantial condensation, could facilitate contamination with and multiplication of Legionella pneumophila.

Commissioning

286. The design specification for the SDGH air conditioning system required sophisticated plant to be operated by reasonably skilled operational engineers. Accordingly in our view the commissioning of the plant had two principal objectives: to ensure that the whole plant performed as specified, and that the operational engineers acquired the knowledge necessary to operate it in the specified manner.

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287. In the event commissioning achieved neither objective. The plant did not perform as specified, and for the purpose of our Inquiry our expert engineering advisers (aided by the hospital engineers) had to make considerable efforts to establish how it did indeed function. It also became clear during the Inquiry that before those efforts were made the hospital engineers had an inadequate understanding of the plant's operation - a state of affairs that was not surprising given the circumstances of the commissioning of the SDGH.

288. The foreshortening of the commissioning period created a number of problems, many of which are set out in paragraph 152 in Chapter 7. The evidence repeatedly brought home to us the importance of proper commissioning and the inadequacy of the commissioning of the cylinder 4 air conditioning system. Recommendation 11 follows. We have come to the conclusion that the problem is not simply one of achieving the proper commissioning of items of plant; but that the process should be extended to include the preparation of an operational manual, supplemented by training the hospital engineers on site in the operation of complex plant or systems. To achieve this we think that consideration should be given to the retention on site of one or more commissioning engineer for a significant time after a hospital is handed over (see Recommendation 12).

Guidance On Operation And Maintenance Procedures

289. We noted the possibility that the hospital's operational engineers did not always receive copies of all relevant guidance and publications on the operation and maintenance of the hospital's engineering systems (for example Mr Denne said in evidence that he did not expect Mr Rutter to have received a copy of HN(80)39). We also had evidence of two instances of inadequate advice being given by Dr Nnochiri. In December 1982 he advised Mr Denne to reject certain guidance set out in HN(80)39 in favour of a conflicting opinion contained in a discussion paper prepared by Professor Ayliffe for the West Midlands Regional Cross Infection Services Committee. That resulted in an unnecessary conflict of loyalties, ultimately and rightly resolved by Dr Scully. Again, in January 1985, Dr Nnochiri failed to give proper consideration to the hospital engineers' proposals for the maintenance of the cooling towers, which they had properly put before him for his expert guidance. In consequence Dr Nnochiri was understood to approve measures which included reducing the

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c. an inadequate fall on the drain from the OPD chiller battery tray to the vertical drainage stack;

d. partial blockages of the cooling tower drainage system in cylinder 4;

frequency of draining and cleaning to once per year from the twice-yearly regime advised by HN(80)39, notwithstanding the knowledge that cylinder 4's cooling tower water system had already been contaminated with Legionella (see Chapter 4).

Training Of Hospital Engineers

290. Overall, the knowledge and understanding of the hospital engineers were inadequate; but that comment does not reflect upon them personally. Indeed, we were impressed by their commitment throughout the response to the outbreak and its aftermath. We think, however, that they could have been better trained in the operation of the air conditioning plant so as to minimise the risk of contamination with Legionella, in the light of increasing knowledge of the organism. Their deficiencies in part reflected the inadequacy of the SDGH's commissioning; but we also note the lack of training facilities and courses, which we recommend should be made available (see Recommendations 13 and 14).

Biocides

291. We consider that a review of the use of biocides is urgently required. From the evidence we heard and submissions made to us, we conclude that there are considerable problems in the biocide control of Legionella in cooling tower water systems, and a committee of experts should urgently be convened to consider these problems (Recommendation 9).

292. The concentration of a biocide necessary to prevent the multiplication of Legionella and the generally higher concentration required to kill it can be measured in laboratory conditions. In cooling tower water systems the conditions are different, largely unknown, and likely to vary from place to place and time to time. Depending on the condition of a particular water system, the biocide could be much more or much less effective than in the laboratory, and conclusions about the biocide's likely efficacy in such a water system should be drawn from laboratory findings only with considerable caution. In addition, the activity of some biocides is significantly influenced by the condition of the water. For example, chlorine is inactivated by organic material and the bacteriocidal efficacy of chlorination decreases rapidly as the pH value rises above 8.

293. Because of their ability to prevent the growth of bacteria and (generally in higher concentrations) to kill them, biocides may be used in two ways:-

a. high concentrations may be applied for limited, but sufficient, periods to kill organisms already in the water system; or

b. lower concentrations may be applied for long periods to prevent the multiplication of (though not kill) organisms which find their way into the system.

294. Whatever the concentration of biocide, it will tend to fall in time due to instability or inactivation of the agent or if the system is drained and refilled with fresh water. If the concentration of the agent fails below its effective level before its lethal action is complete some organisms will survive. If the concentration falls below its inhibitory level those organisms, or others that find their way into the system, may be able to multiply.

295. It follows that effective biocide regimes require judgements about the efficacy in field conditions of the biocide used, and about the persistence of effective concentrations based on knowledge of its likely decay and dilution in the system. If the conditions are relatively constant, it will be possible to apply an inhibitory concentration continuously. If "shot dosing" is used, a judgement will be required about how long an interval (if any) can be tolerated after the concentration has fallen below the inhibitory level. Estimates of the necessary amounts and frequency of biocide additions will of course, be seriously awry if there are marked, and especially unrecognised, fluctuations in drainage and addition of fresh water.

296. At the SDGH there were two problems. First, as a result of a series of errors the quantities of biocide and the dosing intervals were markedly different from what had been intended. Second, it emerged very late in the course of the engineering investigations that the volume of the cylinder 4 cooling tower water system and the volume of water drained and replaced were greatly different from what had been previously understood. The volume of the pond was considerably less, having the result of increasing the concentration of biocide; but the rate of water loss and addition of fresh water, and the consequent dilution of biocide, was considerably more.

297. In the light of the foregoing we think that had Fospur (see Part II of Chapter 9) through Mr Pickering expressly confined their attention to keeping the cooling tower water system clean there could have been no complaint. Mr Pickering's failure to calculate and administer the correct dosages was balanced by his conscientious attendance to inspect the state of the water and by his adjustments (however speculative) designed to correct apparent problems. Unhappily his employers clearly asserted that Kortokil 2020 was capable of inhibiting the growth of Legionella (see paragraph 188 in Chapter 9). Thus Mr Pickering and through him the hospital engineers were led to believe, erroneously, that the proposed water treatment could be relied on to keep the system free from Legionella.

298. Recommendation 8(c), (d) and (e) and Recommendation 16 are intended to reflect our comments set out above regarding the volume, composition and condition (particularly in relation to total dissolved solids, conductivity and pH) of a cooling tower water system which is to be treated with biocides. We emphasise especially the importance of promulgating essential information clearly and of keeping careful records of all relevant factors (see Recommendations 16(c) and 18 in particular). If any doubt arises concerning the state of the water system we recommend that the cooling tower water system's pond be drained completely and replenished with fresh make-up water.

HN(80)39

299. We recognise the value of the Health Notice HN(80)39 in drawing attention to the risk of an outbreak of Legionnaires' Disease occurring in a hospital, and in suggesting preventive action. We consider its advice on chlorination, thorough inspection and cleaning twice yearly remains broadly valid. Our criticism is chiefly that the document assumed, and continues to bear, the status of being the only operational guidance from the DHSS for hospital engineers on the subject, and for that purpose it is inadequate.

300. We believe it was never intended that HN(80)39 should purport to be a code of engineering practice; certainly its terms are inadequate to constitute an effective code, particularly for operational engineers whose level of experience demands more than an aide memoire. That being so, the failure of the DHSS to amend Estmancode, as promised in the text of the

Health Notice, was all the more serious; and given that omission, we consider the DHSS had a duty to keep the Health Notice under constant review, and to up-date it to take account of the experience that had been accruing since 1980.

301. This leads us to the explanations for the failure to revise the Notice set out in Chapter 9, paragraphs 170-172. Neither impresses us. We can see no reason why receipt of Dr Bartlett's report, whenever expected, should have been a pre-condition for reviewing this Notice. No doubt such a report would have prompted a review, but the latter could and should have been preceded by earlier revision, if necessary by reference to some such ad hoc committee as was involved in its initial preparation. Again, the confidence expressed by the DHSS in the efficacy of the Notice reflected a misapprehension as to its terms and effect. It may be that Dr Zutshi could fairly have contended that where there had been reported outbreaks of the disease the establishments concerned could subsequently be shown not to have observed such guidance as was given by the Notice, but we cannot accept the converse for which he contended. The Notice was not a code, and the concept of compliance with it so as to obviate the risk of an outbreak has no good factual basis. In making these comments we have the advantage of seeing HN(HAZARD)(86)1. Its drafting in advance of receipt of Dr Barlett's final report and its detailed supplementation of HN(80)39 respectively serve to support our views.

302. Recommendation 10 necessarily follows. We emphasise that if amendment of Estmancode is to be further delayed a revised Health Notice must be issued urgently and be accompanied by a code of practice adequate for use by operational engineers so that they may understand fully the underlying risks.

Engineering Expertise

303. Chapter 10 makes clear the importance for CDSC of having engineering expertise available. It also makes clear how such expertise was obtained for their investigation into the Stafford outbreak. The one engineering scientist knowledgeable in this field and known to them, Mr Harper, happened to be available and was willing to attend.

304. We are concerned about the element of chance in that arrangement, the more so because Mr Harper is now in private employment. We noted that CDSC were not aware of a comparable engineering expert within the Health Service, and that there had been a recent difficulty when CDSC had required the help of an engineer in another context. Therefore we think that a list of engineers with relevant experience who would be available to CDSC or any Health Authority at short notice should be prepared and maintained (Recommendation 15).

305. The engineers in question should be employed within the Health Service. They should have acquired expertise by training and experience in investigating and preventing problems of hospital infection, and should be willing to undertake emergency secondment to assist at an outbreak. We prefer this course to the suggestion made to us in evidence that one or more engineers should be seconded to CDSC itself. While we can see advantage in the selected engineers undertaking training and refresher periods with CDSC (or any other relevant organisation such as CAMR), we think it important that they should maintain their normal careers: prolonged detachment adversely affects engineering expertise and career prospects. In this context we draw attention to the expertise relating to Legionnaires' Disease now available among the hospital engineers in Stafford.

CHAPTER 13: RECOMMENDATIONS

Introduction

306. The recommendations set out below follow from our comments on the medical and engineering aspects (Chapter 6 and 12 respectively) of our investigations into the cause of the outbreak in Stafford and the adequacy of the measures taken to deal with it. We must emphasise that these recommendations are based entirely on the Stafford outbreak, and therefore represent our response to one particular situation. When we have concluded Part 2 of our Inquiry we will make further recommendations which will have wider implications for air conditioning plant wherever it is needed; and for the use of water for industrial and domestic purposes.

Part I: Medical Recommendations

1. Each large District General Hospital should prepare a plan, analogous to the major accident plans already in existence, to cover major medical emergencies (paragraph 127).

2. More expertise in infectious disease should be made available, and more posts in this specialty should be created nationally (paragraph 131).

3. Recognised routes for referral of laboratory specimens to specialist laboratories should be reinforced, and consideration given to using courier services rather than the post for urgent specimens (paragraph 135).

4. The function of the Control of Infection Technician/Nurse should be re-established at Stafford (paragraph 135).

5. There should be a full review of all aspects of the microbiological services at Stafford (paragraph 135).

Part II: Engineering Recommendations

Primary Recommendations

6. The extent to which the design of future hospitals should include reliance on air conditioning should be subject to scrutiny (paragraph 282.

7. Such air conditioning as is included in the design of future hospitals should not incorporate wet cooling tower systems (paragraph 282).

8. With respect to existing hospitals our present recommendations are (see paragraphs 281 and 298):-

a. urgent consideration should be given to replacing any wet cooling towers with an air-cooled system;

b. the potential for infection from any existing wet cooling towers should be urgently assessed by site inspection so that preventive measures specific to the site can be considered, for example the resiting of fresh air inlets in relation to water cooling towers;

c. the operation of existing wet cooling tower systems should be subject to regular inspections, at which times a clear report of the operational status of the cooling water system together with the relevant meter readings should be recorded in a dedicated log. Operational procedures will need to be developed for this purpose. They should include assessment of the levels of total dissolved solids (TDS), conductivity, and pH;

d. ideally there should be continuous dosing with biocides in quantities calculated by reference to water composition, volume and dilution, together with any other relevant factors so as to achieve and maintain the necessary concentration. The latter should be monitored regularly, and in particular on any occasion when actions or circumstances may have adversely affected it;

e. if intermittent dosing is undertaken (say, on the advice of a water treatment expert in the light of particular circumstances), an automatic injection system linked to the continuously measured volume of make-up water should be used. The measuring devices for the system should be designed and positioned to give prominent, unambiguous display, in particular of the volumes and of the operation intervals;

f. the air conditioning of essential areas in a hospital, especially the operating theatres, should not be entirely dependent upon a single cooling tower water system, thus inhibiting its shutdown for cleaning maintenance;

9. A committee of experts should be urgently convened to consider all aspects of the use of biocides in minimising the risk of the multiplication of Legionella pneumophila in hospital cooling tower water systems (paragraph 291).

10. So much of HN(80)39 as specifies preventive action should be reconsidered and redrafted as a matter of urgency. Whether through such redrafting or through a revision of Estmancode, or through the preparation of some suitable associated document, there should be a code of good practice established for the operational engineer (paragraph 302).

11. The requirements for the commissioning and handover of a new hospital, and of any substantial plant installed in an existing hospital, should be subjected to careful review in the light of the comments made in Chapter 12, paragraphs 286-288, in order to assess the efficacy of existing contractual provisions and whether any need for revision exists.

12. We recommend further that attention be given to the ways in which hospital engineers should be introduced to the operation of unfamiliar equipment and systems at the time of handover (paragraph 288).

13. Courses should be instituted at suitable national venues to train hospital engineers in the safe management of hospital water and air conditioning systems. Subsequent refresher courses should be similarly instituted to ensure that such engineers are apprised of developments in knowledge and technique (paragraph 290).

14. In conjunction with such courses, proper operational manuals should be prepared and issued to hospital operational engineers. Such manuals should be regularly updated to take account of all developments in knowledge and technique concerning engineering plant and its operation (paragraph 290).

15. A register of such experienced operational engineers should be prepared and maintained, so as to provide CDSC and any Health Authority with a known source of readily available expertise. The experience of such engineers would be greatly enhanced by periods of secondment to CDSC and like bodies and through regular contacts with non-Health Service experts, perhaps organised by the DHSS in collaboration with the professional associations of Hospital Engineers (Recommendation 15).

Secondary Recommendation

16. With respect to existing cooling tower water systems in hospitals our present recommendations (see paragraph 298) are:-

a. the water should be regularly tested for total dissolved solids (TDS), conductivity and pH. The measurements should be recorded in a dedicated log;

b. if any such measurement (TDS, conductivity or pH) is found to be significantly above the normally encountered level, or if there is any reason to doubt the efficacy of the biocide regime, the system should be drained completely and replenished with fresh make-up water, and the concentration of the biocide re-established;

c. the capacity of any cooling tower water system within a hospital should be established (in a new hospital, during and as part of commissioning), and should be specified, together with any other material data, on a permanent plaque to be affixed in a prominent position, preferably near the dosage meter;

d. existing cooling tower water systems should be, where necessary and practicable, altered so as to be easily dismantled to facilitate thorough inspection and cleaning. Ideally all components should be capable of being steam cleaned, with facilities for such cleaning being made available on site. An inability to dismantle such a system easily should be regarded as a criterion for early replacement;

e. for the taking of water samples there should be easy access to the ponds of cooling tower water systems at a point remote from the make-up water entry point;

f. the quantity of make-up water supplied to the ponds of cooling tower water systems should be measured with a flow meter;

g. all meters associated with the cooling tower water system should be designed and located so as to be readily calibrated and read.

17. In all hospitals (see paragraphs 283 and 284):-

a. Air breaks should be introduced into all drain lines connecting with drain stacks;

b. water traps in drains from air conditioning plants should feature glass U bends; these should be regularly inspected for cleanliness and an effective water seal maintained. A record of such inspections should be recorded in a dedicated log;

c. there should be easy access to chiller batteries and their drip trays; such access should be regularly used for inspection and cleaning;

18. In the light of evidence given by the hospital engineers, we recommend that attention be given to the keeping of relevant and specific operational records.

APPENDIX 1

REPRESENTATION OF PARTIES

PARTY	COUNSEL	SOLICITOR
i. Throughout public hearings.		
The Committee	R H Jacob QC P N Havers	H M Treasury Solicitor
West Midlands Regional Health Authority and Mid-Staffordshire District Health Authority	I Morris G Harrison-Hall	Solicitor to the Regional Health Authority
Patients and Next of Kin	K Walmsley	Walters and Welch (D Alderson) 22 Eastgate Street Stafford ST16 2LZ
Fospur Limited	B Hargrove QC J Williams	Edge & Ellison, Hatwell, Pritchett & Co (J Aucott) Rutland House 148 Edmund Street Birmingham B3 2JR
Building Design Partnership	P Darling	Last Suddards (R Drake) 128 Sunbridge Road Bradford BD1 2AT

Mid-Staffordshire Community Health Council, 20 Friars Terrace, Stafford ST17 4AU, was represented by Mrs C Baker, Council member, and G Beazley, Secretary to the Council.

PARTY	COUNSEL	SOLICITOR
ii. For medical evidence only.		
Various Doctors	M Spencer	Hempsons (Miss E Pygott) 33 Henrietta Street London WC2E 8MH
Dr E Nnochiri	W Davis	Mark Jewels (M Jewels) 30 Gaolgate Street Stafford ST16 2BG
iii. For engineering evidence only.		
Fairclough Building Limited	C Tetlow	Keogh, Ritson & Co. (D R Tyson) Gould House 59 Chorley New Road Bolton BL1 4QS

Andrews Weatherfoil Limited	W Barnett QC	Cartwrights (C Eskell) PO Box 18 Marsh House 11 Marsh Street Bristol BS99 7BB
A A F Limited	M Cran	Linklaters & Paines (Miss K Coleman) Barrington House Gresham Street London WC2V 7JA

APPENDIX 2

LIST OF WITNESSES WHO APPEARED BEFORE US IN PERSON, OR WHOSE STATEMENTS WERE PUT IN EVIDENCE

* Denotes that statement was put in evidence

a. Patients and Next-of-Kin

Stuart ALVES	(Patient - Ambulance Driver)
Nancy M BAKER	(Next-of-Kin - Mother Died)
Harry BRASS	(Next-of-Kin - Wife Died)
Kathleen BROMLEY	(Patient)
Roger COLLETT	(Next-of-Kin - Father Died)
A H J DEAN	(Patient)
Olwin GREGORY	(Next-of-Kin - Husband Died)
Dorothy M HEATH	(Patient - Ambulance Driver)
Pauline J HUPKA	(Patient - Nursing Assistant, Kingsmead Hospital)
Francis W HURT	(Patient)
Leslie J JACKSON	(Patient)
Carole KEELING and Basil WHITEHURST	(Next-of-Kin - Mother/Wife Died)
Winifred J LEESE	(Patient)
Leslie G MALONE	(Patient)
May C MARSHALL	(Patient)
Geoffrey O'CONNOR	(Next-of-Kin - Father Died)
Robert C PATTISON	(Patient)
Norma K ROWLEY	(Wife of Patient)
Elinor B SUTTON	(Patient - Domestic at District General Hospital)
Margaret B TRINOGGA	(Next-of-Kin - Father Died)
David TURNER	(Patient)
George R VELLA	(Next-of-Kin - Father Died)
Maureen VELLA	(Next-of-Kin - Father-in-Law Died)
Glenda M WHITEHOUSE	(Patient - Out-Patient Ambulance Driver)
John P WILLIAMSON	(Next-of-Kin - Father Died)

b. Local Medical Staff

		SPECIALITY	HOSPITAL
*	Dr Frances B BROOK	Registrar in Histopathology	SGI
*	Dr Nicholas J BURBRIDGE	Consultant Anaesthetist	SDGH and SGI
	Dr Peter R DAGGETT	Consultant Physician	SDGH and SGI
	Dr Andrew J FAIRFAX	Consultant Physician	SDGH and SGI
	Dr Herbert J L FRANCIS	Consultant Physician	SDGH and SGI
*	Dr John A GIBSON	Consultant Physician	SDGH and SGI
*	Dr Percy S GRERO	Consultant Physician in Geriatric Medicine	Kingsmead and elsehwere
*	Dr Syed IQBAL	Associate Specialist in Geriatric Medicine	Kingsmead and elsewhere
	Mr John C LOTZ	Consultant General Surgeon	SDGH
	Dr Andrew R MASON	Registrar in Geneal Medicine	SDGH and SGI
	Dr Enyinnaya NNOCHIRI	Consultant Microbiologist	Department of Microbiology
	Dr Sebastian PAULOSE	Consultant Physician in Geriatric Medicine	Kingsmead and elsewhere
*	Dr Frank J PICK	Honorary Pathologist	SGI
	Dr Khalid A RASHED	Registrar in General Medicine	SDGH and SGI
	Dr John A SCULLY	District Medical Officer and Medical Officer of Environmental Health	
	Dr Luigi SOLARO	Registrar in Microbiology	formerly Department of Microbiology
	Dr Hugh R TUBBS	Consultant Physician	North Staffordshire Royal Infirmary Stoke-on-Trent

KEY: SDGH Stafford District General Hospital

SGI Stafford General Infirmary

c. Public Health Laboratory Service

Laboratories

Birmingham

Dr James G P HUTCHISON | Director

Dr Ian D FARRELL

Manchester

* Dr Dennis M JONES | Director

* Dr John CRASKE

Dr Margaret E MACAULAY

* Dr Terence RIORDAN

Preston

Dr David N HUTCHINSON | Director

Stoke on Trent

Dr John GRAY | Director

Centre for Applied Microbiology and Research

Mr P Robin WAIT

Dr John V LEE

Communicable Disease Surveillance Centre

* Dr N S GALBRAITH | Director

* Dr Susan E J YOUNG | Deputy Director

* Dr Marian B McEVOY

Dr Mary C O'MAHONY

Central Public Health Laboratory

* Dr Philip P MORTIMER

d. Department of Health and Social Security

Dr Mary SIBELLAS | Senior Medical Officer

Dr Derek W ZUTSHI | Senior Medical Officer

* Dr D A HOLT | Medical Officer

Mr S RATCLIFFE | Assistant Chief Engineer

e. Other Medical and Scientific Witnesses

*	Professor Graham A J AYLIFFE	Professor of Medical Microbiology, University of Birmingham
*	Dr Thomas H FLEWETT	Regional Virus Laboratory, East Birmingham Hospital
	Mr David HARPER	Engineering Scientist, Consultant to Winton Applied Occupational Hygiene
	Dr Angus McGREGOR	Regional Medical Officer, West Midlands Regional Health Authority
*	Dr R ELSMORE	Microbiologist, Boots PLC
*	Mr B S DREDGE	Deputy County Analyst, Staffordshire County Council

f. Department of Microbiology, Stafford

	Mr Ian L McCARTNEY	Senior Chief MLSO
	Mr Malcolm G HOLLIDAY	Chief MLSO
	Mrs Margaret A HODGSON	MLSO

g. Health Authority Engineers

	Mr Roger M CUTCLIFFE	Regional Engineer, West Midlands RHA
	Mr Colin B DENNE	District Works Officer, Mid-Staffordshire HA
	Mr E Patrick MILES	District Engineer, Mid-Staffordshire HA
	Mr Alan F RUTTER	Unit Engineer, SDGH
	Mr Stephen C DALTON	Mechanical Engineer, SDGH
	Mr Anthony HENSHALL	Electrial Engineer, SDGH
*	Mr J R FREER	Estates Officer, Mid-Staffordshire HA

h. Designers and Contractors

*	Mr K ANGOOD	Hotchkiss Ductwork Limited
	Mr Melvyn CLARK	AAF Limited
	Mr J R J ELLIS	Engineering Services Partner, Building Design Partnership

Mr Robert GRINDEY	Fairclough Building Limited
Mr Stephen D LANG	Senior Engineer, Building Design Partnership
Mr Bernard LEATHERBARROW	Fairclough Building Limited
Mr William MARTIN	Andrews Weatherfoil Limited
Mr Peter MacDONALD	AAF Limited
Mr Patrick PICKERING	Fospur Limited
Mr John H TROUGHEAR	formerly Associate, Building Design Partnership

i. Administrators

Mr Kenneth F BALES	General Manager, West Midlands RHA
Mr James BARTLETT	General Manager, Mid-Staffordshire HA

APPENDIX 3

WRITTEN SUBMISSIONS RECEIVED FROM:

a. Patients and Next-of-Kin

Francis and Catherine ACKLAND

J W BAILEY

David A BERRY

M W M CLIFT

Roger T CRUTCHLEY

Mrs J DERRY

Ernest N KENT

Martin H MOODY

Mrs G M O'CONNOR

David J SCULLION

David E WILLIAMS

b. Engineering

AAF LIMITED	
Oliver G BLACK	formerly Chief Clerk of Works (Building)
John BOLTON	Chief Works Officer, DHSS
Ian R BROWN	formerly Service Engineer, Satchwell Controls Limited
Roger M CUTCLIFFE	Regional Engineer, West Midlands RHA
Brian E R DEANE	formerly Control Service Engineer, Satchwell Controls Limited
Colin B DENNE	District Works Officer, Mid-Staffordshire HA
James I DIMBYLOW	formerly Site Engineer II (Mechanical) West Midlands RHA
Dr S P FISHER-HOCH	Research Worker
S A GREGORY	Member of the Public
HOUSEMAN (BURNHAM) LIMITED	

G R MIDDLEMASS	Assistant Regional Engineer, West Midlands RHA
Bryan C SARGENT	Site Engineer (Electrical and Mechanical) West Midlands RHA
SATCHWELL CONTROLS LIMITED	
M A STOTHERS	William Steward & Co Ltd

c. Other

Kenneth B F BALES	General Manager, West Midlands RHA
BOOTS COMPANY PLC	
FOSPUR LIMITED	
Dr N S GALBRAITH	Director, CDSC
H HILL	District General Manager, SE Staffordshire HA
James G P HUTCHISON	Director, Birmingham PHL
Dr David J MOORE	Central Electricity Generating Board
NATIONAL UNION OF PUBLIC EMPLOYEES	
Dr Andrew S T LAMB	Consultant Anaesthetist SDGH and elsewhere
R Tomlinson	City Scientific Officer, City of Birmingham Environmental Health Department

WORLD HEALTH ORGANISATION WORKSHOP ON LEGIONNAIRES' DISEASE

APPENDIX 4

EXPERTS ADVISING THE COMMITTEE OF INQUIRY

Medical

Dr John O'H TOBIN	FRCP, FRCPath.
Dr John T MACFARLANE	DM, MRCP.

Engineering

Dr Geoffrey W BRUNDRETT	B Eng, PhD, C Eng, M I Mech E.
Michael H SMITH	C Eng, MIMech E, FIHosp E, MBIM.

HEALTH NOTICE Appendix 5 HN(80)39

DEPARTMENT OF HEALTH AND SOCIAL SECURITY

To: Regional Health Authorities)
Area Health Authorities) for action
Boards of Governors)

Community Health Councils - for information

November 1980

HEALTH SERVICE MANAGEMENT

LEGIONNAIRES DISEASE AND HOSPITAL WATER SYSTEMS

SUMMARY

This Notice describes the measures authorities should take to reduce the chances of an outbreak of Legionnaires Disease occurring.

BACKGROUND

1. The bacterium, *Legionella pneumophila*, which causes Legionnaires Disease is widely distributed in nature and commonly found in surface water and soil. It is not normally found in mains water but, given the right conditions, can establish itself in water systems in buildings. Conditions which favour the colonisation of water systems include stagnation and temperatures between 20°C and 45°C. The organism is destroyed by high temperatures and probably by exposure to chlorine and other biocides.

The presence of *Legionella pneumophila* rarely leads to outbreaks of Legionnaires Disease but it has been isolated from water in air-conditioning cooling towers, humidifiers and other water samples from buildings, a few of which have been associated with small outbreaks of the disease in the UK. Sporadic cases have occurred where no such association has been demonstrated.

The predominant route of infection in Legionnaires Disease is by inhalation and outbreaks in both the UK and abroad have been attributed to exposure of susceptible individuals to contaminated aerosols from cooling towers or from shower-heads. There is no evidence that the disease is transmitted by ingestion or directly from person to person.

Knowledge of the epidemiology of Legionnaires Disease is incomplete. Accordingly, it is not possible to give precise guidance on action which might be taken to prevent outbreaks of the disease or after one or more cases have occurred. Further, programmes designed to keep hospital water supplies free from contamination at all times would be economically impracticable. For the present, therefore, guidance is limited to those measures which might be taken to reduce the chances of an outbreak of Legionnaires Disease occurring while drawing attention to the need for action to be determined locally where cases which might have originated in hospital are confirmed.

No additional finance can be made available for these measures. Any additional expenditure must be contained within authorised cash limits.

PREVENTATIVE ACTION

2. Any action proposed should be discussed with the local Medical Officer responsible for environmental health matters.

a. *Cooling Towers and Evaporative Condensers*. These should be disinfected by chlorination to five parts per million, drained, thoroughly inspected and cleaned twice yearly or at the beginning and end of each season and when shut down for any significant length of time for any other reason. The use of anti-scaling compounds and algicides after cleaning will assist in minimising the opportunity for colonisation of the systems by the bacterium. Estmancode will be amended to include this recommendation in due course.

b. *Humidifiers.* The reservoirs and pipework of humidifiers using recirculating water systems should, in a similar manner to cooling towers, be disinfected, drained, thoroughly inspected and cleaned twice yearly or when shut down for any significant length of time. Estmancode will be amended to include this recommendation in due course.

c. *Water Storage and Distribution Systems.* Ideally cold water should be kept and distributed at a temperature below 20°C, which is the temperature below which bacterial growth is restricted. Since this is not generally practicable it is recommended that all reasonable means should be used to keep the temperature down as near to 20°C as possible and to eliminate any local abnormal temperature rises in the cold water system. This would not be relevant to separate drinking water systems where these are supplied directly from the water company's service mains.

d. *Hot Water Systems.* Hot water should be stored at a temperature of 60°C and distributed at a temperature not less than 50°C. Water at this temperature will not normally be passed through thermostatically controlled shower-heads and other similar fittings. The regular disinfection of these is a problem which is under study and further recommendations will be made as soon as possible.

ACTION IN THE EVENT OF AN OUTBREAK OF LEGIONNAIRES DISEASE ATTRIBUTABLE TO AN INTERNAL SOURCE OF INFECTION

3. Identification of the cause of infection and institution of measures to control it will be initiated by the local Medical Officer responsible for environmental health matters, advised by the consultant responsible for the control of hospital infection, the Public Health Laboratory Service and if required the Communicable Disease Surveillance Centre at Colindale (Tel. 01 200 6868). Engineers may expect to be asked to take action which can entail adjustment of temperature of water supplies or the use of biocides including chlorine. It would not be practicable to comment on specific remedies since each outbreak must be treated according to the type of system involved and other factors. Engineers may find it useful to consult their local Water Authority now regarding the measures which might have to be taken, including the use of biocides, in the event of an outbreak.

EXISTING GUIDANCE

4. Advice on the design and distribution of hospital cold water systems and on water hygiene generally is contained in Hospital Technical Memorandum No 27. Authorities should consider whether any measures should be taken to ensure that the quality of the potable water supply is not unnecessarily being impaired by any inadequacies in the hospital supply and distribution systems.

All existing guidance on domestic hot water circulating temperatures is superseded by this Notice.

ADVICE TO STAFF

5. In hospitals where circulating water temperatures have been raised to 50°C in accordance with this Notice all appropriate staff should be advised of the change.

FURTHER INFORMATION

6. Any enquiries on the engineering content of this Notice should be addressed to Mr F H Wykes at the address below Tel. 01-388-1188 ext 959 or 496. Enquiries relating to the control of infection should be addressed to Dr M Sibellas, Room A307, Alexander Fleming House, Elephant and Castle, London SE1 6BY, Tel. 01 407 5522, ext 7340.

ACTION

7. Health Authorities are asked to ensure that the necessary measures are taken and that appropriate staff are advised. Copies of this Notice have been sent to Medical Officers of Environmental Health.

From:

Directorate of Works Operations
Room 834, Euston Tower
286 Euston Road
London NW1 3DN

Tel. 01-388-1188 Ext 959 or 496

G3/L122/58

Further copies of this Notice may be obtained from DHSS Store, Health Publications Unit, No 2 Site, Manchester Road, Heywood, Lancs OL10 2PZ quoting code and serial number appearing at top right-hand corner.

D21/J29/JM

APPENDIX 6

A RECENT HISOTRY OF VENTILATION IN HOSPITALS

Ventilation and air conditioning in hospitals has only developed in the past 30 years or so. Before the 1950-60s ventilation in hospitals was generallly achieved by natural means, possibly with limited mechanical extract in special areas. Post mortems and even major surgery was often conducted in rooms with little more than openable windows as the source of ventilation. Typical of this era for in-patient accommodation was the Nightingale style of ward with its high 15 foot ceilings and large openable windows set in opposing walls to provide natural lighting and cross-flow ventilation. Heating of such spaces was achieved by the use of conventional, hospita-pattern, radiators. However even at this time it was recognised that good ventilation assisted in patient recover, although it was not known why.

In the late 1950s and early 1960s the first generation of Hospital Building Notes was issued by the Ministry of Health. These publications set out the policy and planning requirements for clinical and service departments in hospitals and also provided for the first time minimum standards for lighting, heating and ventilation. For more specialised departments, such as operating theatres, they included recommendations on air quality, humidity and temperature control. They also established principles of air flow from clean to less clean zones. These documents set the standards for Hospital Boards to use and established the design criteria for the next 30 years.

The Ministry of Health also embarked on a number of prototype development projects such as the Greenwich District Hospital. This project, like others later (eg the Charing Cross Hospital) was developed on a restricted site and close to major traffic routes and these factors contributed substantially to the types of buildings which were built. The Greenwich Hospital was a deep planned, three storey building which, because of local noise and air pollution problems, had sealed windows and was fully air conditioned. The new Charing Cross and Royal Free hospitals were also among the first in the UK to have extensive areas of air conditioning and full mechanical ventilation.

Additionally other more standardised planning systems were being developed - standard departments (maternity and psychiatric) and "Best Buy" hospitals. "Best Buy" was intended to encompass economically the benefits of planning, design and construction in a repeatable form. Unlike Greenwich, "Best Buy" hospitals had very limited mechanical ventilation, relying almost totally on natural ventilation.

With the proposed expansion in hospital building during the late 1960s and early 1970s a more flexible planning system than Best Buy became necessary, and the first major system to be evolved was "Harness". The Harness system included all the benefits and experience gained from the Department's previous development work and incorporated many improvements on the standards specified in the Building Notes. To provide the degree of flexibility required a modular, chequer-board building shape was adopted, the effect of which was to make environment in these areas, limited conditioned air was provided from a high velocity dual duct ventilation system - mixing boxes providing individual zone control. For the first time, perimeter spaces were designed to be mechanically ventilated. The temperature of the perimeter spaces was regulated by means of a conventional low pressure hot water radiator system using individual thermostatic valves in each room.

Financial restrictions imposed on the health building programme in the early 1970s and the problems associated with the control and management of large 1200 bed hospital brought about the demise of Harness. Several small projects using the Harness principle were built at Southlands, North Tees and East Birmingham and much of the planning data and policies was used in the project at Stafford.

Despite the financial restructions the need to build more new hospitals remained. The development work on Harness provided a sound basis on which to formulate a new system of hospital planning which would be flexible enough to meet immediate loca needs but could also form the first stage of a larger hospital. The system deveoped was called Nucleus. Economies in design and construction were considered and incorporated if the standards or operation of the hospital were unaffected. In terms of ventilation this meant that limited conditioned air for core areas could be retained, but the perimeter spaces would once again be naturally ventilated.

Progress in determining the requirements and standards of ventilation in specialist areas had also been made and documented in the Lidwell report "Ventilation in Operating Departments" and the Howie "Code of Practice for the Prevention of Infetion in Clinica Laboratories and Post Mortem Rooms". The findings of both these working party reports were included in the appropriate Nucleus ventilation systems.

More recent studies conducted on behalf of the DHSS into low energy hospital development have indicated that substantial savings in energy can be achieved by sealing the building and thus controlling air infiltration. In order to maintain normal odour control, CO_2 and oxygen levels supply air would be introduced into each perimeter space and heat reclaimed from the clean and dirty extract systems.

Studies and investigations at Nucleus hospitals have indicated that perimeter accommodation up to 8 metres deep can be successfully ventilated in both winter and summer by natural means. However natural ventilation is uncontrollable and leads in winter to a waste of energy (when two or three times the volume of air actually required has to be heated). Studies have also been pursued in the field of part-recirculation of air for normal theatre procedures.

March 1986 D Pratt

Appendix 7

HAZARD

HEALTH NOTICE

HN(HAZARD)(86)1

DEPARTMENT OF HEALTH AND SOCIAL SECURITY

To: Regional Health Authorities)
District Health Authorities)
Special Health Authorities for the London) for action
Postgraduate Teaching Hospitals)

30 January 1986

HEALTH SERVICES MANAGEMENT

LEGIONNAIRES DISEASE: INTERIM ENGINEERING GUIDANCE NO 2

COOLING TOWERS AND EVAPORATIVE CONDENSERS

SUMMARY

This Notice confirms the preventative action specified for cooling towers and evaporative condensers in HN(80)39 to reduce the risk of an outbreak of Legionnaires Disease. There is concern that the guidance is not being adequately implemented and this Notice stresses the need for thoroughness in cleaning, disinfecting and treating the cooling water, coupled with careful monitoring and documentation of these procedures.

BACKGROUND

1. Evidence to the Stafford Inquiry, together with information available on smaller scale outbreaks of Legionnaires Disease and from the Public Health Laboratory Service, has drawn attention to the need to follow good engineering practices in the maintenance and operation of cooling water systems. It is essential that the treatment, operation and supervision of cooling water circuits are carefully monitored to minimise the risk of further outbreaks. The provisions of HN(80)39 are still applicable and all hospitals should continue to follow the guidance in paragraph 2a of that Notice.

ACTION

2. This information should be brought to the attention of all who need to know or be aware of it. This will include General Managers and Administrators, Works Officers, Engineers, Medical Officers of Environmental Health, Medical Officers, Nursing Officers, Control of Infection Officers, Microbiologists, Safety Liaison Officers and Staff Safety Representatives.

3. All Health Authorities with cooling towers or evaporative condensers should immediately check that their operating and maintenance procedures conform strictly to the Department's guidance and meet the following requirements.

4. **Fundamental requirements**

All reasonably practicable steps should be taken to keep the entire water system biologically clean and disinfected. This involves (a) cleaning and disinfection, followed by (b) clearly defined water treatment.

a. **Cleaning and disinfection**

Chemical dispersants may be necessary to remove the organic material which builds up in cooling water system pipework. For the protection of staff carrying out the cleaning, the cooling water should be chlorinated and circulated for four hours maintaining a minimum level of free residual chlorine of 5 parts per million (5mg/L) prior to draining down and cleaning. The cooling tower internal shell, packing material and pond should be thoroughly cleansed. All debris should be removed or flushed away. Attention should be paid to the integrity of drift eliminators which should be repaired or replaced if damaged or ineffective.

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b. **Water treatment**

This should be implemented immediately after the cooling water system has been cleaned. With the fans off, the fresh cooling water should be chlorinated and circulated for at least six hours, maintaining a minimum level of free residual chlorine at 5 parts per million (5mg/L). The subsequent use of anti-scaling compounds and algicides will assist in minimising the opportunity for colonisation of the system by the bacterium. The responsibilities of any water treatment specialists should be clearly defined. A log should be kept of all these procedures.

5. **Operating requirements**

a. Manual drainage regimes for the cooling water, including frequency, should be specified clearly and must be implemented. Any faults in an automatic bleed system should be rectified immediately.

b. Check weekly that automatic chemical dosing systems are functioning correctly; a record of control settings should be kept.

c. Weekly checks of the cooling water should be arranged (eg total dissolved solid measurements, visual inspection for suspended matter) and of the concentration and total dose of any chemical used in its treatment. When these checks have been made, *if there is any doubt about the cleanliness of the water it should be dumped;* the adequacy of the water treatment regime should be reviewed when refilling the system. All these procedures should be recorded in a log-book set aside for the purpose.

d. Ensure there is ample spacing between the fresh water flow into the tank and the overflow and automatic and manual drainage outlets.

ENQUIRIES

6. Any enquiries on the content of this Note should be addressed to Mr K G Russell, DHSS, Health Building Directorate, Room 315, Euston Tower, 286 Euston Road, London NW1 3DN. (Tel: 01-388 1188 Ext 3749. Alternative extensions 3329 or 3227).

From:

Health Building Directorate [formerly Works Group]
Euston Tower
286 Euston Road
LONDON NW1 3DN

Tel: 01-388 1188 Ext 3841

Further copies of this Notice may be obtained from DHSS Store, Health Publications Unit, No 2 Site, Manchester Road, Heywood, Lancs OL10 2PZ quoting code and serial number appearing at top right-hand corner.

. . . .

For Health Authority use as instructed locally.

TITLE:	LEGIONNAIRES DISEASE: INTERIM ENGINEERING GUIDANCE NO 2	HN(Hazard)86)1
	COOLING TOWERS AND EVAPORATIVE CONDENSERS	30 January 1986

Sent to Department responsible for action: Date . . . .

Action completed: Signature . . . . Location . . . . Date . . . .

Comments on action taken:

Return to after completed action: Date . . . .

APPENDIX 8

OUTCOME OF ANALYSES OF ENVIRONMENTAL SAMPLES TAKEN FROM THE SDGH

1. Legionella pneumophila subgroup Pontiac la recovered from:-

   i. water sample taken from cylinder 4 cooling tower pond on 12 November 1984

   ii. water sample taken from cylinder 4 cooling tower pond on 3 May 1985

   iii. sample of Densofil (insulant) taken from the cylinder 4 OPD chiller battery (Birmingham PHL reference number 18214).

2. Fatty acid profiles consistent with the presence of Legionella pneumophila found in:-

   i. cylinder 4 drip tray ground floor (Birmingham PHL reference number 18216)

   ii. cylinder 4 end drip tray ground floor (Birmingham PHL reference number 18217)

   iii. (possibly) water sample from cylinder 3 cooling tower pond (Birmingham PHL reference number 14575).

3. Legionella not found in:-

   i. cooling tower ponds in cylinders 2, 3, 4 and 5 on 4 May;

   ii. calorifiers, showers, hot and cold taps, leader tanks, raw or treated water, drains, pipes, traps;

   iii. ventilation ducts, fire dampers, bag and rollomatic filters, Densofil insulant (other than 1(iii) above), chiller batteries and drip trays (other than 2(i) and (ii) above);

   iv. dust, mud from SDGH site; standing water on hospital roof;

   v. air samples taken in the OPD, and at the fresh air inlet at rooftop level.

D28/J34

APPENDIX 9

SDGH: TESTS CARRIED OUT BY MID-STAFFORDSHIRE HEALTH AUTHORITY WORKS DEPARTMENT

Date	Test
16 5 1985	Porton Down scientist carried out environmental air samples from air intake at roof level and from OPD ventilation air grilles in Waiting Areas.
17 5 1985	Pressure test carried out to establish relationship between vertical plant drainage stack and chiller battery tray serving OPD from Cylinder 4.
21 5 1985	Further test carried out to confirm that results of above test were common to Cylinders 4 and 5.
24 5 1985	Glass trap fitted to chiller battery drain in place of original copper and reconnected to existing plant drainage system.
28 5 1985	Air sample taken by Porton Down scientists in purple and orange Waiting Areas in OPD supplied by Cylinder 4.
	The plant drainage system was reconnected for test purposes to observe the effects on the water in the glass trap fitted to the base of the chiller battery.
29 5 1985	Test repeated and video made with assistance of Health Eduction Department.
13 6 1985	Plant drainage system subjected to a high volume discharge by draining high level water storage tanks.
14 6 1985	Tests repeated in Cylinders 4 and 5.
17 6 1985	Video camera passed down all vertical stacks; all clear, but could not traverse horizontal underground drain.
19 6 1985	Special drainage clearing machine used prior to further inspection by video camera.
5 & 6 7 1985	Further air sampling by Porton Down scientists on OPD served by Cylinder 4 prior to bringing chiller batteries back into service.
15 7 1985	Special small video camera passed along underground drains revealing further debris.
24 7 1985	Further investigations undertaken on Cylinder 5 chiller battery owing to water not draining through glass trap.
16 9 1985	Air velocity test carried out on Cylinder 4 chiller battery serving OPD witnessed by interested parties. Results presented to Inquiry by Dr Brundrett.

Date	Test
23 10 1985	Test carried out on aerosol generated at Cylinder 4 OPD chiller battery by Porton Down and interested parties. Test to ascertain moisture release off chiller battery was aborted due to inability to check high humidity.
18 12 1985	Cylinder 4 cooling tower functional test carried out which verified operation of tower in conditions similar to those which existed during a portion of the outbreak period. These gave details of evaporation/drift, water throughput of tower and related temperatures, flows and operation of the various components of the plant; confirmation of relationship between water make-up, hours of refrigeration plant run, evaporation; and of "water down drain" rates as difference between water make-up and evaporation. This data back-checked to provide indication of possible conditions during April/early May 1985.

APPENDIX 10

TEXT OF DOCUMENT SUBMITTED TO COMMITTEE OF INQUIRY BY MID-STAFFORDSHIRE HEALTH AUTHORITY ON 3 OCTOBER 1985

Control Parameters For Legionella Pneumophila at Stafford District General Hospital

In response to the request of the Enquiry Team in respect to controls currently in existence at the above, we wish to offer the following information:-

A procedure was produced following meetings with CDSC, Porton Down, PHLS (East Birmingham), West Midlands Regional Health Authority and Mid-Staffordshire Health Authority (Appendix A*) to agree a procedure for bringing the cooling plant back into operation and identify control parameters for the future running of the ventilation, hot and cold water services at Stafford DGH. The specific questions raised by the Enquiry Team are:-

1. Cooling Tower

a. Fan Operation - Switch to automatic operation, ie fan always running prior to water being pumped to cooling tower. The fan is monitored for on/off/tripped once every 24 hours on the Multi-Tour Report.

b. Chlorination - The free residual chlorine level is sampled twice daily and chlorine added so as to maintain 2-5 ppm. The chlorine is added manually and a record made of the tests and amount added. Records are attached showing procedure for monitoring chlorine/pH/TDS. (Appendix B*).

c. Biocides - The current regime commenced on 28 September 1985. This regime was recommended by Fospur and vetted and approved by a water treatment consultant, Envirotest. Copies of Fospur and Envirotest's recommendations attached. (Appendix C*).

d. Multi-Tour Reports - The report notes the time at the commencement of the tour, the outside temperature and the tradesman's initials; also noted are the condenser water temperature, fan operation, ie on/off/tripped, chilled water pump on/off/tripped, refrigeration plant in service/system defect, refrigeration plant number of hours run, chemical tank contents. Sample sheet attached. (Appendix D*).

1.2 Current Maintenance Schedule

See Appendix A*, "Procedure for Running System", pages 4-7, and sample Instruction Sheet, Appendix B*.

In addition to this, the existing PPM schedules as previously referred to in D68+ have been modified to include specific items and time periods from Appendix A*, ie quarterly, half-yearly and yearly.

1.3 Further Steps

a. Within the next two weeks it is proposed to hold a meeting between CDSC, Porton Down, PHLS (East Birmingham) and District to review the present control measures.

* The various Appendices to this document are not reproduced here
\+ Not attached

b. Biocide dosing pumps have been fitted with hours run meters to enable daily checks to be made on delivery of biocides to the cooling towers and weekly consumptions recorded of biocides delivered to cooling towers.

c. The ball valve supplying fresh cold water to the cooling towers is to be re-sited to the opposite side to the drain to prevent short-circuiting.

d. The control mode of the three-way mixing valve to the cooling tower is to be re-evaluated to ensure proportional control to the tower - fan running at all times.

e. All towers other than Cylinder 4 have been chlorinated, drained and cleaned and left dry for the winter period. The procedure identified in Appendix A* will be applied upon re-start. Cylinder 4 refrigeration plant and cooling tower will be monitored through the various departments it serves to establish the full necessity for its function. A programme has been identified to the users to enable twice-yearly total strip down and cleaning.

f. Submission made in the 1986/87 Annual Programme to replace all open evaporative water cooling towers to air-to-air type. (Estimated cost - £200,000 - £250,000).

g. Water treatment contract to go out to further tender for a 3-year period, including revised tendering documentation and service report system.

h. Operational procedures to identify all control parameters and settings for easy reference to all staff.

i. Seal 3" gap between air intake louvres to cooling tower and air shaft.

j. Whilst copper and steel corrosion monitoring plates have been suspended in the cooling tower ponds, a specialist corrosion engineer is to visit to advise on amount of corrosion taken place on Cylinder 2, 3 and 5, condensers and associated pipework.

2. Out Patients Department Ventilation

a. Fan Operation - The time clock has been removed and the fan now runs 24 hours per day, 7 days per week. The fresh air inlet damper will be adjusted to fully close and be interlocked to the fan starter through the proposed Energy Management System later in the year.

b. Chlorination - As is referred to in Appendix A* a chlorination regime for the chiller battery is in existence for both regular maintenance on a 3-monthly basis and also a procedure should the ventilation plant be taken out of service for any reason for a time greater than 24 hours.

c. Multi-Tour Reports - Checks on fan status on multi-tour are carried out daily to check on/off/tripped, temperature and filter condition. (Copy of Multi-Tour Report attached, Appendix D*).

2.2 Current Maintenance Schedules - Daily checks on chiller battery trap condition and air break traps are carried out as shown in attached Appendix E*. In addition to this the existing PPM schedules as previously referred to in D66 have been modified to include specific items and time periods from Appendix A*, ie quarterly, half-yearly and yearly.

2.3 Further Steps

a. Operational procedures to identify all control parameters and settings for easy reference to all staff.

b. As part of the proposed Energy Management System will include for modifications to the control circuits to ensure that no flow of hot or chilled water takes place through the heater or chiller batteries when the fan is stopped for any reason and, as referred to previously, the damper will close completely upon plant shutdown.

c. Further investigation is taking place to establish the replacement of the existing rollamatic filter with a higher efficiency type which will prevent air leakage that is associated with rollamatic type filters.

d. Provision of new drip trays which are easier to remove for maintenance and inspection. The proposed drip tray will be coated with a corrosion resistant paint and will include baffle plates and angle deflectors.

2.4 Domestic Hot and Cold Water Services and Showers

It should be noted that all spray nozzles have been removed from all taps throughout the District General Hospital to prevent aerosolation. Full details of the procedures are included in Appendix A*. Also guidance has been given to all engineering staff throughout the District in respect to other health premises. (Appendix F*).

2.5 Sampling and Tests

These are described in Appendix A* and the directions which are given are included in Appendix G*. Off-site testing is carried out by the East Birmingham PHLS and the frequency of these tests for Legionella will be subject to the meeting referred to in para 1.3(a).

2.6 Drain in Lower Ground Duct

The underground drain in the lower ground duct is currently being assessed to see if it can be modified to provide manhole inspection chambers at each junction from each cylinder and the drain to the sump split so as to allow flow from only one direction. This should ensure better facilities for access and inspection and allow easier maintenance to be carried out.

3 October 1985

APPENDIX 11

TESTS CARRIED OUT ON BEHALF OF THE INQUIRY

1. The design, construction, operation and maintenance of the cylinder 4 cooling tower were carefully examined and considered.

2. Meteorological data recorded at Keele University were checked against weather data for Stafford. No significant distinction was found.

3. With the aid of Dr Dickson, Electricity Council Research Centre, tracer gas experiments were conducted in the cylinder 4 cooling tower.

4. Dr D J Moore of the Central Electricity Research Laboratory calculated the evaporation rates of water droplets.

5. Dr J V Lee and Mr P J Dennis, both of CAMR, conducted various experiments with particle counters into the capability for aerosol generation in the ductwork by the OPD chiller battery.

6. Dr Lee of CAMR tested Kortokil 2020 under laboratory conditions and confirmed that in the right dosage it was capable of killing Legionella pneumophila.

7. The County Analyst reported on the contents of certain samples submitted to him.

We are greatly indebted to all the above for their assistance.

APPENDIX 12

ENGINEERING ASPECTS OF THE OUTBREAK OF LEGIONNAIRES' DISEASE IN STAFFORD: A SUBMISSION TO THE COMMITTEE OF INQUIRY BY DR G W BRUNDRETT AND MR M H SMITH

CONTENTS:-

FEBRUARY 1986

Dr G W Brundrett is with the Electricity Council Research Centre
Mr M H Smith is with the Gateshead Health Authority

1. INTRODUCTION

We are conscious that the engineering data is incomplete and that data which we have needs to be taken in close association with the epidemiological facts. However, we offer our view of the engineering factors as we know them, in the hope that it may clarify some issues and quantify others and hence assist in the difficult task facing the Inquiry Team.

2. BACKGROUND

Stafford District Hospital is a modern air conditioned building of modular design, fig. 1. The services for each zone are contained within a centrally sited cylinder. Four cylinders serve the whole hospital. These vertical cylinders pass through all the floors and continue upwards for a further two floors above roof level. The fresh air inlet, the cooling tower, the water tanks and the pumps and mechanical refrigeration compressors are housed within these two uppermost floors. The air supply and extract and the drains for the air conditioning equipment run vertically through the cylinder.

The microbiological and epidemiological surveys showed that there was Legionella in the cooling tower water of cylinder four and in the insulation material within the end caps of the chiller battery to the Outpatients Department. There was also a high concentration of non culturable Legionella in the chiller tray of the unit supplying the Outpatients Department. These were of the same type which infected the patients.

We will now explore the presence of Legionella in the cooling tower water, its multiplication and its dissemination.

3. PRESENCE OF LEGIONELLA IN THE COOLING TOWER

Our assumption is that Legionella is a common bacteria and when naturally airborne in the outdoor air can readily be trapped by the water sprays through which large quantities of air are drawn in a cooling tower.

The temperature of the air supply to the air conditioned space in the hospital is controlled by passing it through heat exchangers. When cooling is required cold water is drawn through the chiller heat exchanger battery from a recirculating ring main of chilled water. This chilled water ring main is kept cold by refrigeration. The heat extracted by the refrigeration process is rejected to the cooling tower water by the refrigerant condensers. This cooling tower water is pumped up to the top of the tower and sprayed down over a filler pack of thin moulded plastic sheeting within the tower while air is drawn up through the tower. This counterflow of air and water creates a strong evaporative cooling effect and the cooled water is collected in the pond of the tower (fig. 2) and recirculated through the condenser back up to the sprays.

The modern conventional treatment to kill bacteria is to provide a regular routine dose of biocide to the cooling tower pond water. At Stafford the dosing frequency of the Legionella biocide was every twelve days (11th and 23rd April during the outbreak). Subsequent measurements made by the hospital engineers showed that the quantity of biocide injected into the cooling tower of Cylinder 4 was half of that injected into the other smaller cooling tower in Cylinder 2.

This makes the cooling tower in Cylinder 4 the least protected of the two towers in use at the time of the outbreak.

4. MULTIPLICATION OF LEGIONELLA IN THE COOLING TOWER WATER CIRCUIT

Our assumption about the microbiology is that Legionella will not multiply in water whose temperature is below 20°C or above 46°C. We need to explore how the cooling tower water can dwell between these temperatures.

Once the refrigerant compressor is called into operation it dissipates its heat into the cooling tower water circuit. This is done by the water pump continuously circulating the water around the lower loop through the threeway valve. With one of the four available compressors in Cylinder 4 working at its lowest power (~100 kW thermal) the temperature in this loop of water would rise at the rate of approximately 1°C/minute.

The function of the three-way mixing valve shown in fig. 2 is to blend the two water streams together, one from the cooling tower pond and the other from the lower recirculation loop, to create a temperature of 26°C for the water at the inlet of the condenser loop.

When the refrigerant compressor runs, the temperature in the recirculation loop will rise until it reaches 26°C. At this temperature the three-way valve will start to close the port from recirculation and open the port from the pond outlet. The automatic controller will continue this action until the temperature of the water sensed at the inlet to the condenser loop starts to fall.

The water circuits of three of the hospital's four cooling towers contained the flow restriction valve shown in fig. 2. The cooling tower in Cylinder 4 contains a gate valve in place of the flow restrictor. It is possible to use this gate valve as an unconventional flow restrictor by adjusting it by hand to provide a restriction to the flow. The Hospital Engineers report that this gate valve had not been used as a flow restrictor.

In these circumstances the three-way valve will still try to divert water to the cooling tower as the temperature of the water in the loop rises above 26°C. However, the valve manufacturers report that the flow resistance of the valve when fully open to the 28 litres/sec design flow is 1 metre head of water. Since the nozzle outlets of the cooling tower water sprays are approximately 2m above the pond water surface, then no water would be expected to reach the tower sprays when the three-way valve is set to full recirculation.

Experiments on the Cylinder 4 cooling tower, operated as the hospital engineers believe to be the mode in April, showed that the cooling tower fan switched on when the three-way valve was half closed to recirculation and water was sprayed into the tower when the three-way valve reached 7-8 tenths of its travel.

The proportional band of the controller of the three-way valve is 10°C and therefore the recirculating water would reach a temperature of over 30°C before spraying into the cooling tower. The water circuit therefore comprises a recirculating loop of increasingly warm water which is then sprayed through the pack and collected in the pond.

Once water is sprayed into the tower the chilling capacity of this 850 kW (thermal) cooling tower will quickly lower the temperature of the recirculating water. The temperature sensor in the water of the condenser inlet will note this chill and the controller will set out to open the three-way valve to full recirculation in the loop and close off the port to the cooling tower pond.

This cycle will repeat itself two or three times each hour depending upon the weather and the cooling requirements of the refrigeration plant. An illustration from some comprehensive measurements undertaken by the hospital engineers in December is shown in fig. 3.

In this mode of operation peak temperatures in the recirculation loop reached 33°C while the water in the pond was 18°C and the outdoor air temperature 8°C.

The hospital engineers undertake daily spot checks on plant operation. Amongst many other duties they record the temperature of the water in this recirculation loop. Records from the 3rd September, 1984 to April-May 1985 for the two cooling towers in all year operation showed an average water temperature in Cylinder 2 cooling tower of 18.6°C and 23.1°C for Cylinder 4.

The cooling requirements of some of the specialist rooms such as operating theatres mean that the cooling tower of Cylinder 4 is in more use than that of Cylinder 2. In the month of April the operating hours of the refrigeration plant averaged 2 hours/day for Cylinder 2 and 8 hours/day for Cylinder 4.

The time the cooling tower is in operation is closely linked to the hours of operation of the refrigeration equipment of the air conditioning plant. The operating hours of both will increase with warmer weather. The relationship between refrigerant compressor operation and the daily maximum temperature is illustrated in fig. 4.

The operating mode of the cooling tower and the warmer weather towards the end of March would encourage longer cooling tower operation at the higher temperatures and would permit multiplication of the Legionella in the recirculating piping.

This view of the cooling tower operation has assumed that the gate valve in the position in fig. 2 marked 'pressure regulating valve' was fully open all the time at the start of the outbreak. There have been differing views on the position of this valve. The valve itself was found to be stiff at ½-1 turn open, but moved freely over the rest of its travel.

The actual setting of this valve is quite critical to the operating mode of the tower. If the valve was almost closed then it would create an additional resistance to the water flow through it and when the three-way valve moved to divert water to the tower then the water would reach the tower earlier. This could, in the first instance, increase the degree of control of the water to the tower but it could easily allow water to flow to the tower with the fan off. This latter situation would dramatically increase the aerosol flow to the air gap in the floor down to the fresh air supply of cylinder 4.

5. AEROSOL GENERATION AND TRANSPORT

The two potential sites for aerosol generation are through bubbling in the drain of the chiller battery in the Outpatients Department or more directly from the fine spray associated with water falling through the cooling tower. These can be considered both as independent sites or in combination.

The terminal velocity of falling droplets of water in normal atmospheric conditions is illustrated as a function of size in fig. 5. Typical working velocities of the air in different parts of the air conditioning equipment are also presented. A lower terminal velocity means that the droplet will more readily be transported by the air stream.

Let us examine them in turn.

(a) Chiller drains

The chiller battery, even if in operation in winter, is unlikely to create significant condensate. It is possible that the drain traps could dry out and provide a direct link between the normally pressurised air supply ducting and the drain stack which is dedicated to the air conditioning drains in this hospital. Some of the traps in the equipment associated with Cylinder 4 were reported to be dry at the time of the hospital engineers investigation on the 16th May (three or four traps contained water, one of these was the centre trap of the Outpatients Department chiller battery).

Experiments by the hospital engineers showed that when the drains to other floors were temporarily blocked off and the manual drain of the cooling tower pond opened, then fluctuating pressures were recorded in the drain to the Outpatients Department chiller battery drain. These averaged 100 mm (4") water pressure in the drain stack compared with only 90 mm (3½") water head of pressure at the base of the Outpatients Department chiller battery fig. 6. A video record showed that water could flow into the trap when the manual drain of the cooling tower pond was opened. There was doubt about the actual flow through the manual valve in this test. Subsequently, the maximum flow through the ½" automatic valve was measured by the hospital engineers to be 9 litres/min and the maximum through the 1" manual drain was 24 litres/min.

An experiment to explore what happened when pressure fluctuations occurred in the drain stack was conducted by CAMRA scientists. The simplest simulation was to supply air at a static pressure of 100 mm (4") water gauge at the end of the plant room drain pipe to represent that caused by the falling water observed in the video film. The optimum amount of water necessary to create the best aerosol was poured into the glass trap of the chiller battery of the Outpatients Department air supply. The original drain tray and absence of baffle plate was restored to simulate the plant at the start of the outbreak. The introduction of 100 ml of water to the trap almost closed the airway. Pressurising the drain pipe to 100 mm water gauge (4") and operating the Outpatients supply fan in a normal manner did create turbulence within the trap (figure 7). The instrumentation did not record any aerosol change within the duct.

The experiment was repeated with the Outpatients Department fan abruptly turned off. As the supply fan to the Outpatients Department slowed down, so the pressure in the supply ductwork fell. This meant that the pressure drop across the trap increased and the turbulent agitation in the trap became more vigorous. This increased vigour was recorded as an increase in the aerosol quantity in the duct. Some water was then blown from the trap into the condensate tray and the finned chiller, wetting a central patch about 30 mm x 30 mm square. Bubbles were observed between the fins of the heat exchanger and the aerosol concentration was shown to have increased in the ductwork. The effect was a transient one. Approximately 50 ml of the trap water was lost from the trap within minutes and the agitation *subsided. Some of the water would flow into the drain pan,* some wetted the patch of fins and some was entrained into the air stream.

These tests established that an aerosol could be generated in the *trap if the trap* was only partially filled with water. When the Outpatients Department fan was running down, *as it did at the end of each day shift*, measurable quantities of aerosol went down the ductwork for a few minutes after the fan came to rest. Some of this would be drawn by the reverse air flow which would then be expected to be induced principally into the operating *theatre floor. Any other water flowing into the trap at night* would follow this route. It is possible some aerosol would go to the Outpatients Department during the daytime although the quantity was too small to be measured by the Porton Down experiment.

There is some uncertainty about the water quantity which would have flowed down the drains during April. The automatic blowdown device was effectively disconnected for an unknown part of April, which would have prevented automatic flow to the drain. However, estimates of water consumption of the tower made by the hospital engineers from occasional measurements of the use of corrosion inhibitor solution, suggest that significant amounts of water were supplied to the tower. This quantity could have been by the overflow which the hospital engineers noted had happened in the past.

The likelihood of infection created by this route would be expected to be more pronounced in the first hour of occupancy of the Outpatients Department and much less throughout the rest of the day. The night-time backflow could infect full time patients and staff on duty after 5.0 p.m. on the Theatre floor served by Cylinder 4 but not the daytime staff.

(b) Cooling tower

Accepting that the tower operation was similar to that recorded in the hospital engineers tests of December, then the tower fan would always switch on before the water sprays were created and would only switch off after the full sprays had switched off.

The cooling tower manufacturers report that they expect the amount of water droplets to be blown out of the top of their tower to be 0.2% of the water recirculation rate (i.e. 3.4 litres/min of droplets).

Data on the size distribution of droplets from cooling towers is rare. However, one set of data has been supplied by Marley USA for a tower using their popular type of herringbone patterned drift eliminator. This is illustrated in fig. 8 and shows that only a small part of the drift (approx. 10%) is below 50 μm diameter.

Tracer measurements showed that 0.1% of contaminant released in the Cylinder 4 cooling tower was entrained into the air inlet and distributed in the building by the air supply when the wind was north westerly (fig. 9).

This aerosol would be reinforced by the much smaller quantity of aerosol generated by the draining of the filler pack in the cooling tower. Some 150-300 litres (30-60 gallons) of water continue to drain for a few minutes after the fan switches off. There is also a small but continuous dribble of water estimated at 20 litres/min (5 gallons/min) by the hospital engineer over approx. 5% of the pond area adjacent to the air inlet gap.

Smoke tracers had shown that when the tower fan was off and when the wind was north westerly air flow came across the top of the tower pond and short circuited through a gap in the plant room floor into the air inlet, fig. 10. Some 10% of contaminant introduced into the cooling tower was entrained into the fresh air supply to the building under these circumstances.

The filtration efficiency for the filter unit mounted at the entrance to the Outpatients Department ductwork is presented in fig. 11. Many of the larger droplets would be expected to be captured by the filter but a large number of the smaller size (<5 μm dia.) would pass through the filter. The droplets collected on the filter would be expected to be killed by the biocidal coating on the filter medium.

The change in droplet diameter as the aerosol enters the main air inlet in Cylinder 4 is illustrated in fig. 12 as a function of initial size and ambient relative humidity (from D.J. Moore). The particularly high outdoor relative humidities during April would mean that the droplets would not evaporate as quickly as normal. The viability of the microorganism is better in these more humid conditions.

The direct link of the cooling tower aerosol to the whole ventilation system supplied from Cylinder 4 has been established. This would be expected to contaminate all the rooms supplied by this air.

(c) Cooling tower and drain

One further possibility is that water from either the drain or from condensate could rest in the ductwork and be regularly reinfected by the microorganisms from the air supply. Traces of chemicals and corrosion marks on the base of the ductwork leaving the chiller battery in the Outpatients Department's supply established that mains water has been there although it is not known when. This water could act as another multiplier, particularly in the very warm conditions which could occur during the backflow of air at night from the Outpatients Department, when the Outpatient Department fan was off but the other two floors were supplied with air.

In the month of April there would be negligible condensate from the chiller battery from the outdoor air during the day but a little could occur in the night when backflow occurred from the Outpatients Department.

However, when the Outpatients ductwork by the chiller battery was deliberately flooded as an experiment, we could find no evidence of re-entrainment of the water. It is possible that when such water dries out then any microorganisms could be entrained into the air stream in a dry form although there is no evidence to suggest that water was present in the ductwork at the time of the outbreak.

6. WEATHER FACTORS

(a) Comparisons between data from Stafford and Keele University

Daily temperatures are taken at 8.30 a.m. by the hospital engineers at a hospital approx. 1 mile away from the Stafford District Hospital. The nearest comprehensive weather station is at Keele University, which is approx. 16 miles away. Daily temperatures are recorded at 9.0 a.m. at Keele. A comparison of these two sets of data for the month of April 1985 is given in fig. 13. In general the agreement is good (within ±2°C for most data). The temperature data from Keele can therefore be used as a reasonable guide to that occurring at Stafford.

Wind direction, averaged hourly, is also recorded at Keele. Continuous records of wind direction on the top of Cylinder 4 were recorded during the ventilation experiments over two half days. The comparison of the results is shown in fig. 14. There was very good agreement on one of the days but less satisfactory agreement on the other.

(b) Links between the outbreak and the weather

The relationship betwen compressor operation and the outdoor temperature has already been described and illustrated in fig. 4. As the outdoor temperature increased, so the hours of plant operation, including cooling tower operation, increased. The rapid change in temperature in early April would be consistent with the start of the outbreak (fig. 15).

The relationship between the infection and wind direction is illustrated in fig. 16. If the wind is in the quadrant 240-330° then any drift from the cooling tower outlet would be directed towards the air inlet (fig. 17) during the hours 9. a.m.-5 p.m.

Accepting that the wind data from Keele is the best guide to wind direction, then in general the prevailing wind during the time the Outpatients Department was occupied would carry cooling tower drift into the general direction of the air inlet to Cylinder 4. There are several exceptions when infection occurred and the wind was not in this direction.

There were three days when the wind changed direction significantly during the day. A brief examination was made to see if the infection rate changed within the day to match the lining up of the plume with the air inlet. There was no effect.

Wind direction is, therefore, generally favourable to blowing the tower plume towards the air inlet but the link with infection is not perfect.

The records for relative humidity at Keele showed the highest values ever recorded by them for April. This high relative humidity would prolong the life of the aerosol because its evaporation rate would be slower. High humidities also favour the viability of the organism itself.

7. CONCLUSION

The cooling tower in Cylinder 4 ran a little warmer than the other towers and was least protected by the quantities of biocide administered. This makes it the most likely tower to become contaminated.

The warmer weather in April increased the time the cooling tower water spent at temperatures around 30°C. This would encourage the multiplication of the Legionella micro-organism.

The warmer weather would also bring the cooling tower into operation for longer periods. The proximity and location of the cooling tower with respect to the air inlet meant that some of the plume would re-enter the air inlet when the wind blew in a westerly direction as it did in April. When the fan was on the droplets would be re-entrained from the outdoor air. When the tower fan was off, there was short circuiting from the tower base to the gap in the plant room floor leading to the air inlet. Such a route would supply contaminated air to all rooms serviced by Cylinder 4.

The partially blocked drain and associated pipework meant that there were conditions when an aerosol could also be generated in the chiller battery drain and hence into the ductwork of the Outpatients Department. This would be small and most vigorous at night when the Outpatients Department fan was switched off and the reverse air flow could carry this contaminated air into the rooms on the first floor.

The decline in infection towards the end of the month could be part of the natural cycle of micro-organisms being replaced by those of another type. The strong shot dose of biocide on the 30th April would be expected to remove the bulk of the contamination and end the infection.

8. ACKNOWLEDGEMENTS

Mr. C.B. Denne, Mr. E.P. Miles and Mr. A.T. Rutter of the Stafford District Hospital for willing and constructive help in the tests.

Mr. M.B. Edge, Department of Geography, University of Keele for the weather data and advice.

Mr. J. Lanoue, Marley Towers, USA for basic tower data.

Dr. D.J. Dickson and Mr. A.R. Marchant, Electricity Council Research Centre for smoke and ventilation tests.

Dr. D.J. Moore, Central Electricity Research Laboratory for calculations on evaporation rates for droplets.

Dr. J. Lee and Mr. P.J. Dennis, Centre for Applied Microbiology and Research for the aerosol and microbiological data.

FIGURES

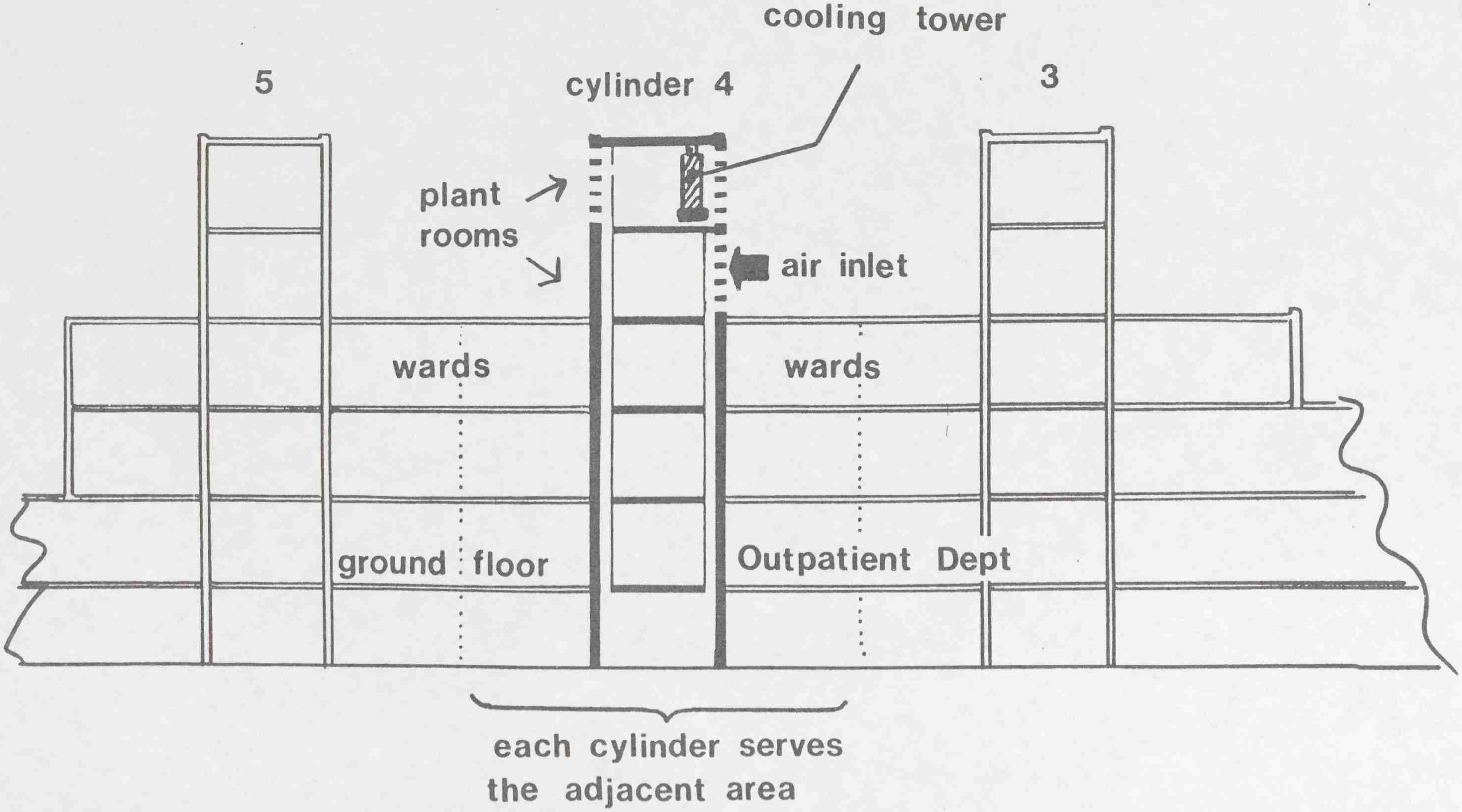


Fig. 1 The modular design concept of the Hospital

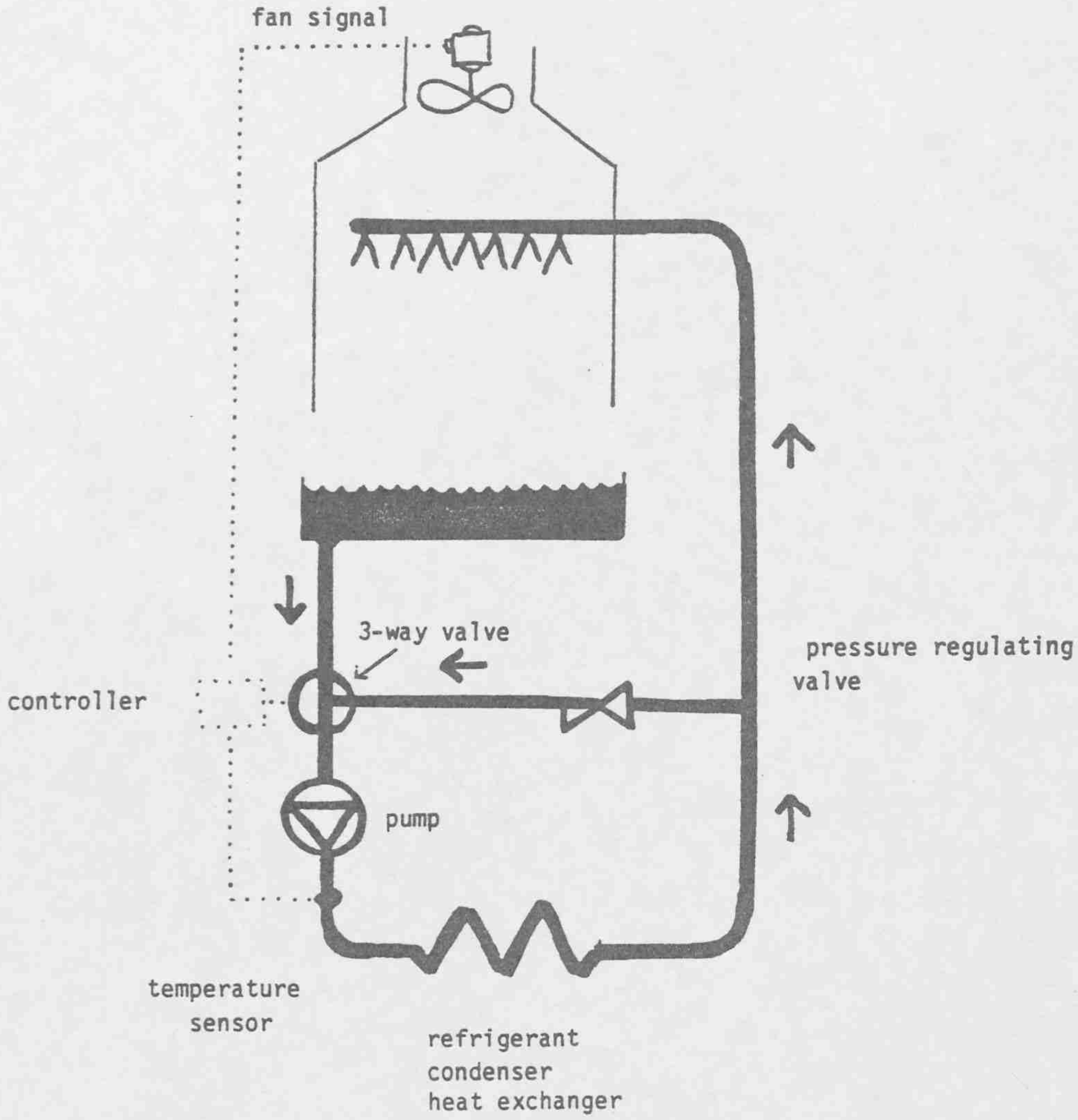


Fig. 2 Diagrammatic flow diagram for the cooling tower

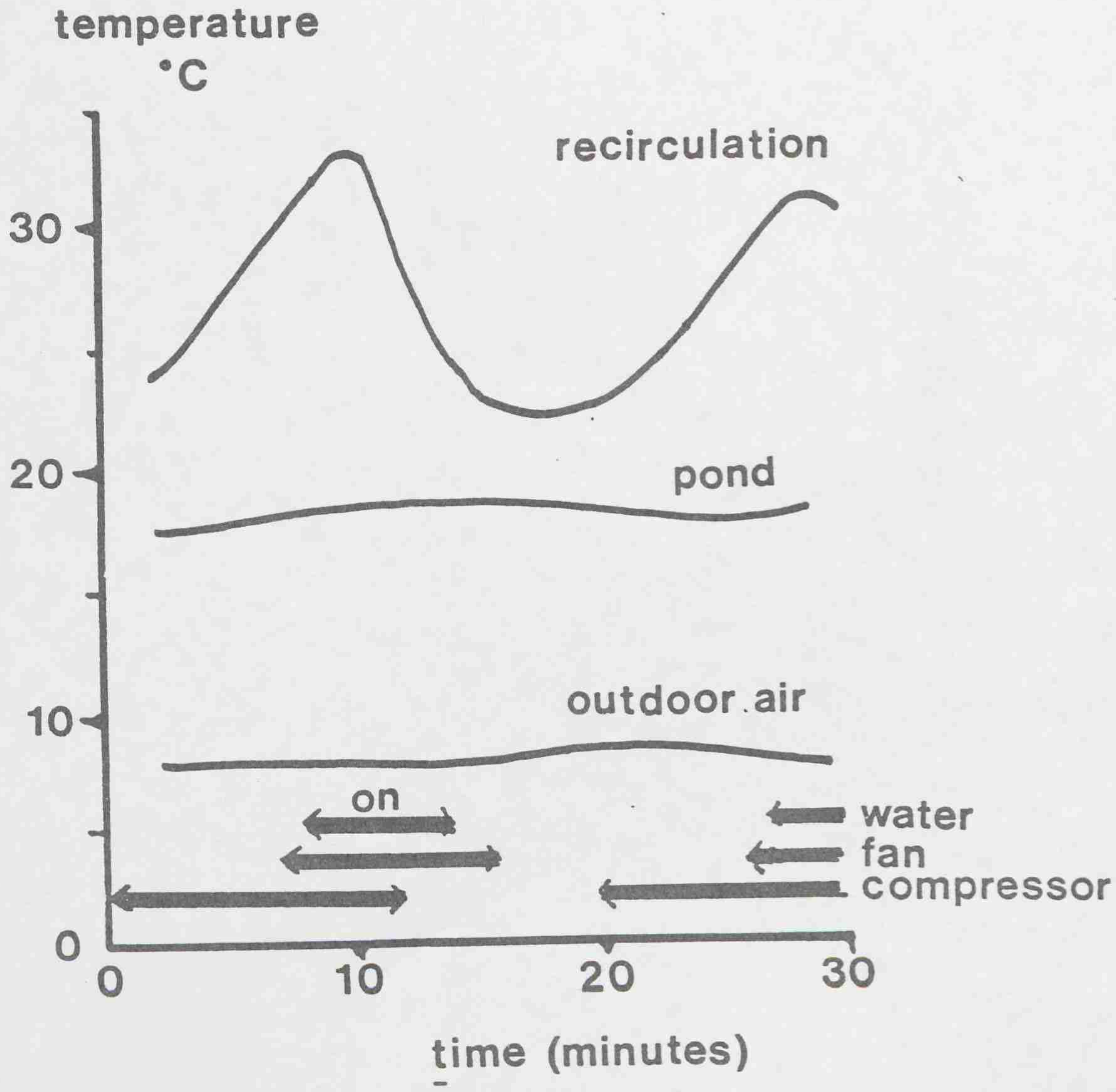


Fig. 3 Operating temperatures of the cooling tower in Cylinder 4
(Stafford District Hospital Engineers Tests December, 1985)

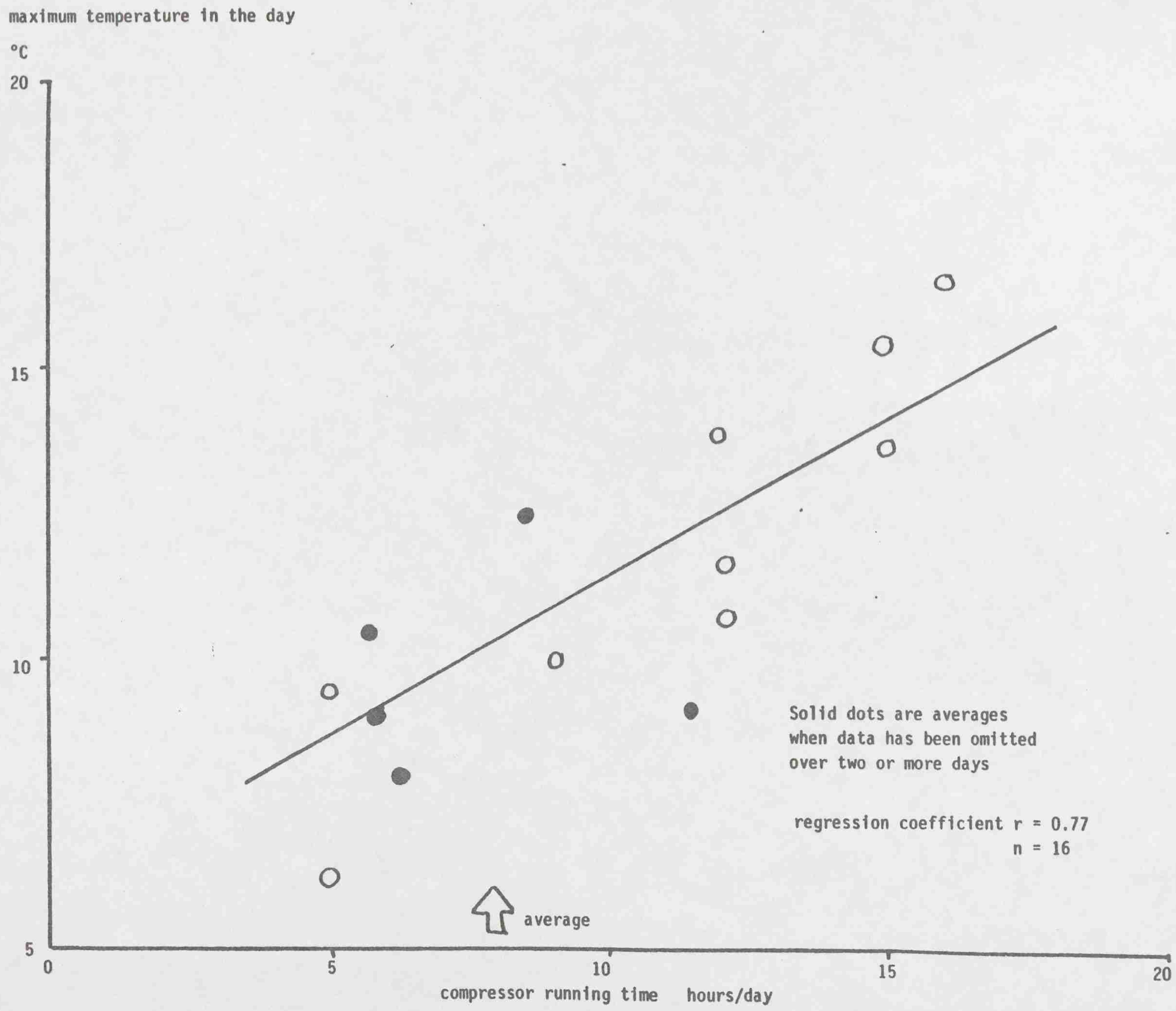


Fig. 4 Relationship between maximum temperature and compressor operation time (Cylinder 4, April 1985)

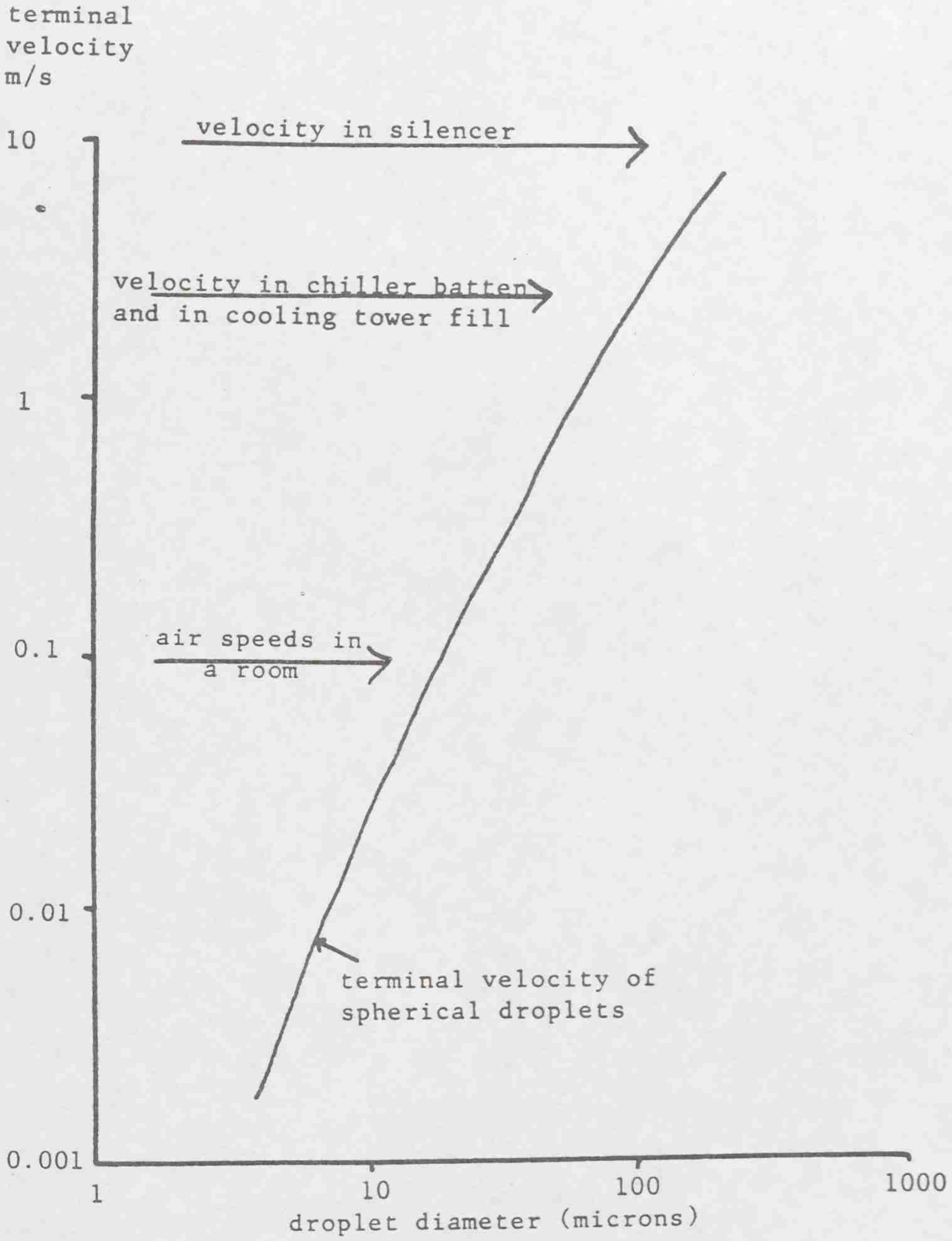


Fig. 5 The relationship between water droplet size and terminal velocity

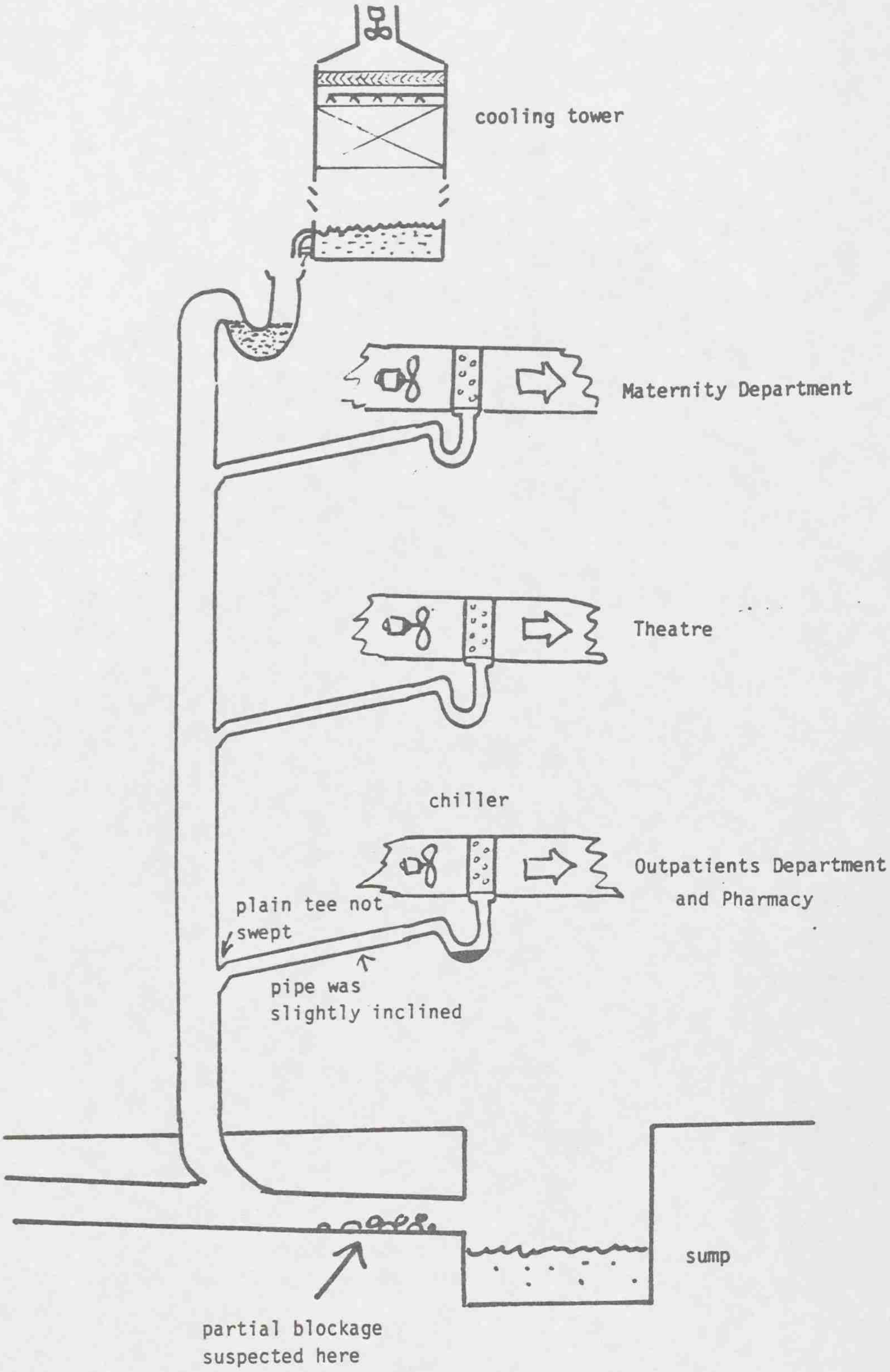
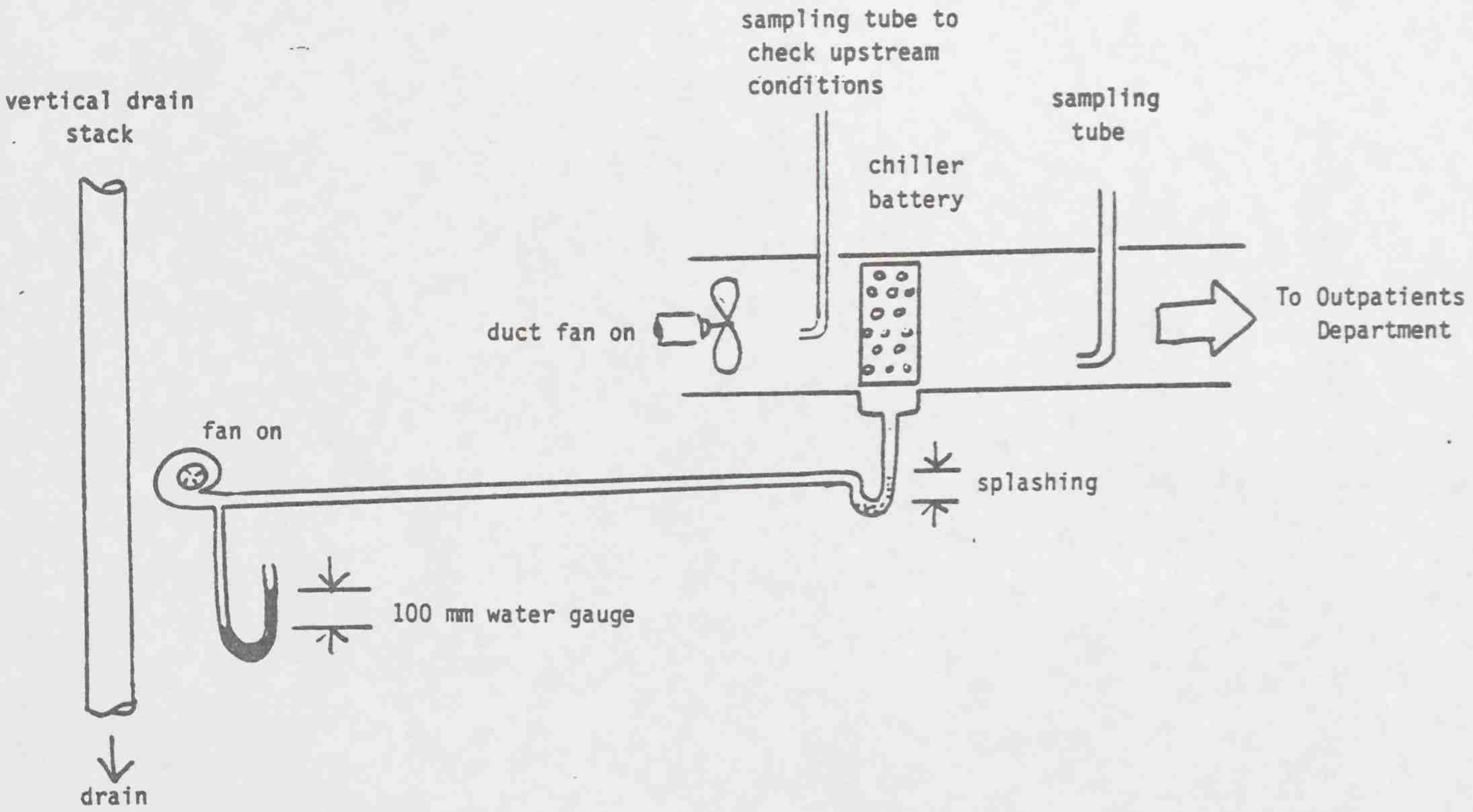


Fig. 6 Arrangement of condensate and cooling tower drains



(a) Applying a fan pressure of 100 mm water gauge at the end of the horizontal drain pipe gave intensive agitation of 100 ml water introduced to the glass trap. However, the instrumentation did not record any increase in particles in the duct.

(b) Repeating the above experiment with the duct fan off increased the degree of agitation in the drain trap and traces of an aerosol were recorded in the duct.

Fig. 7 Aerosol tests in the ductwork to the Outpatients Department (Porton Down Experiment)

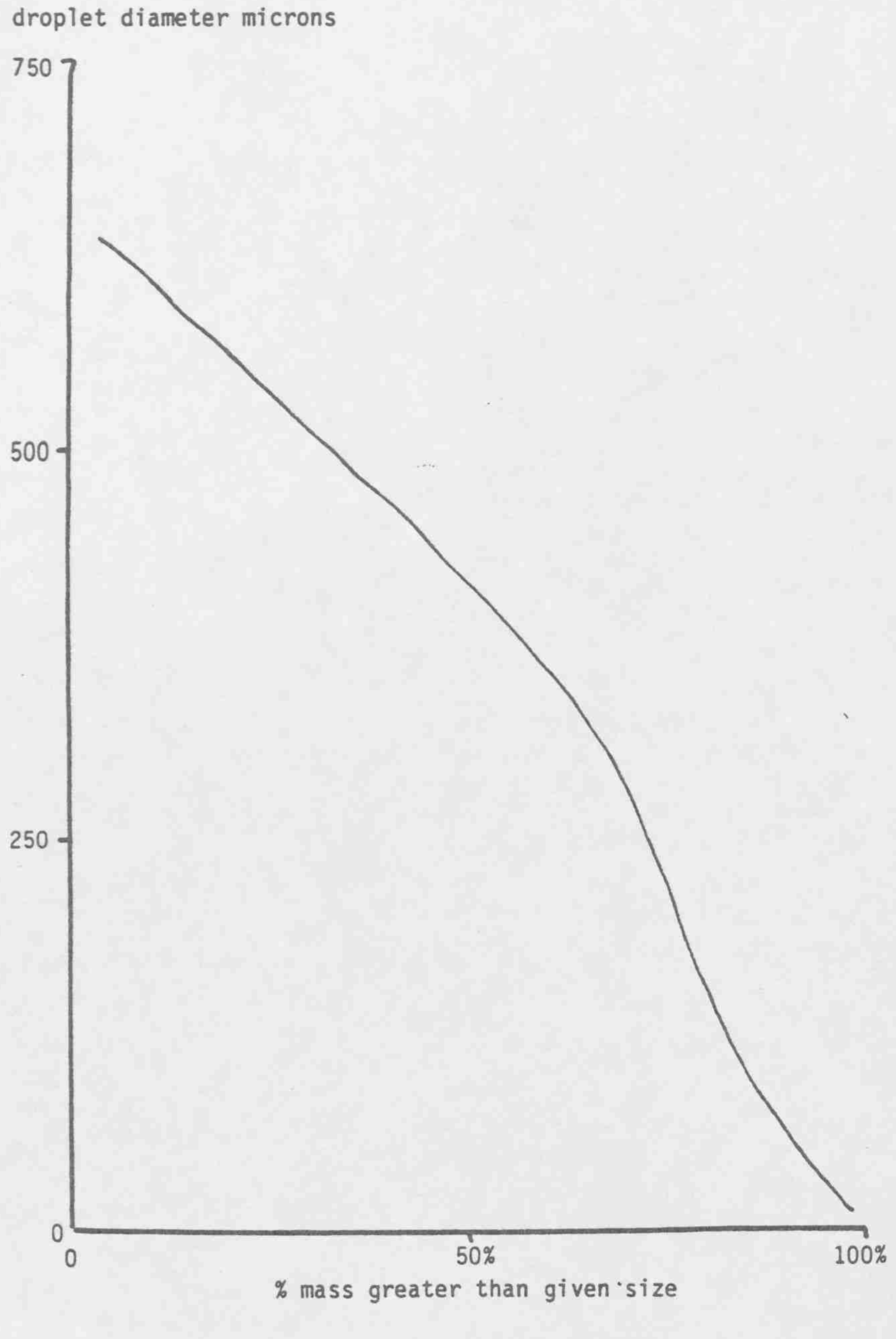


Fig. 8 Illustrative data of mass distribution of drift from a cooling tower (courtesy of Marley Towers, USA)

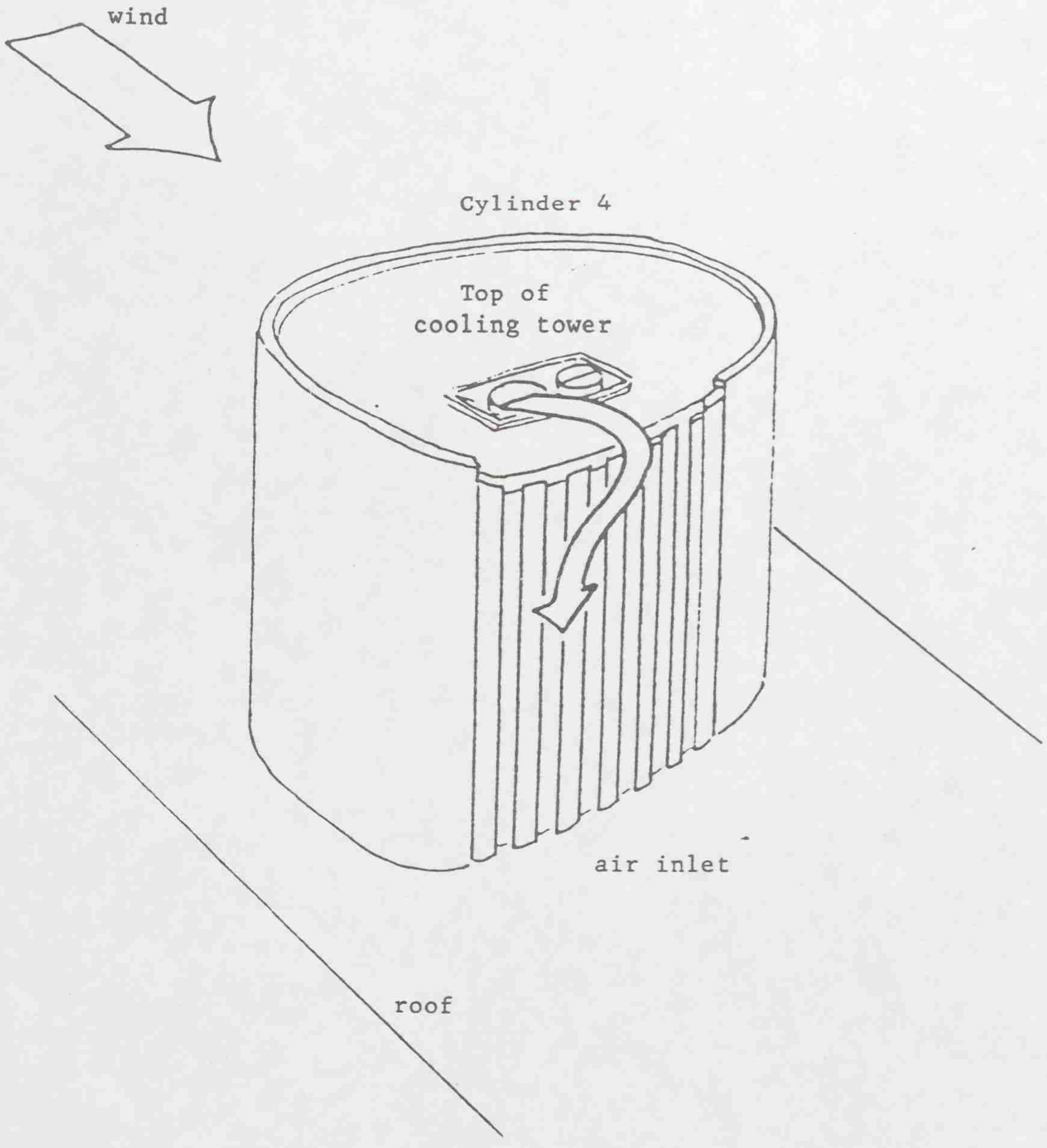


Fig. 9 0.1% of contaminant released in the cooling tower was entrained in the air inlet

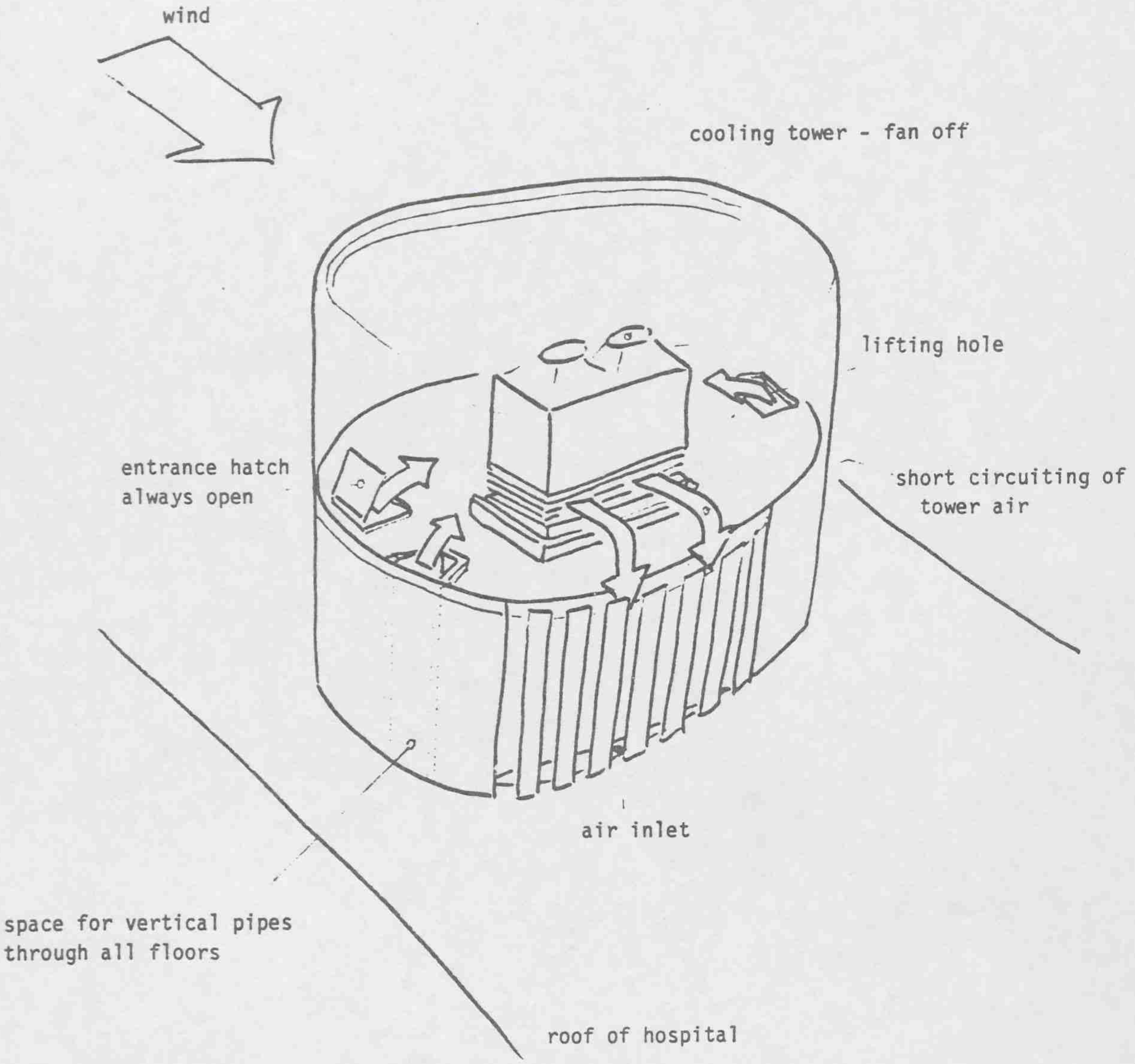


Fig. 10 Short circuiting of air from upper plant room to air inlet when cooling tower fan is off

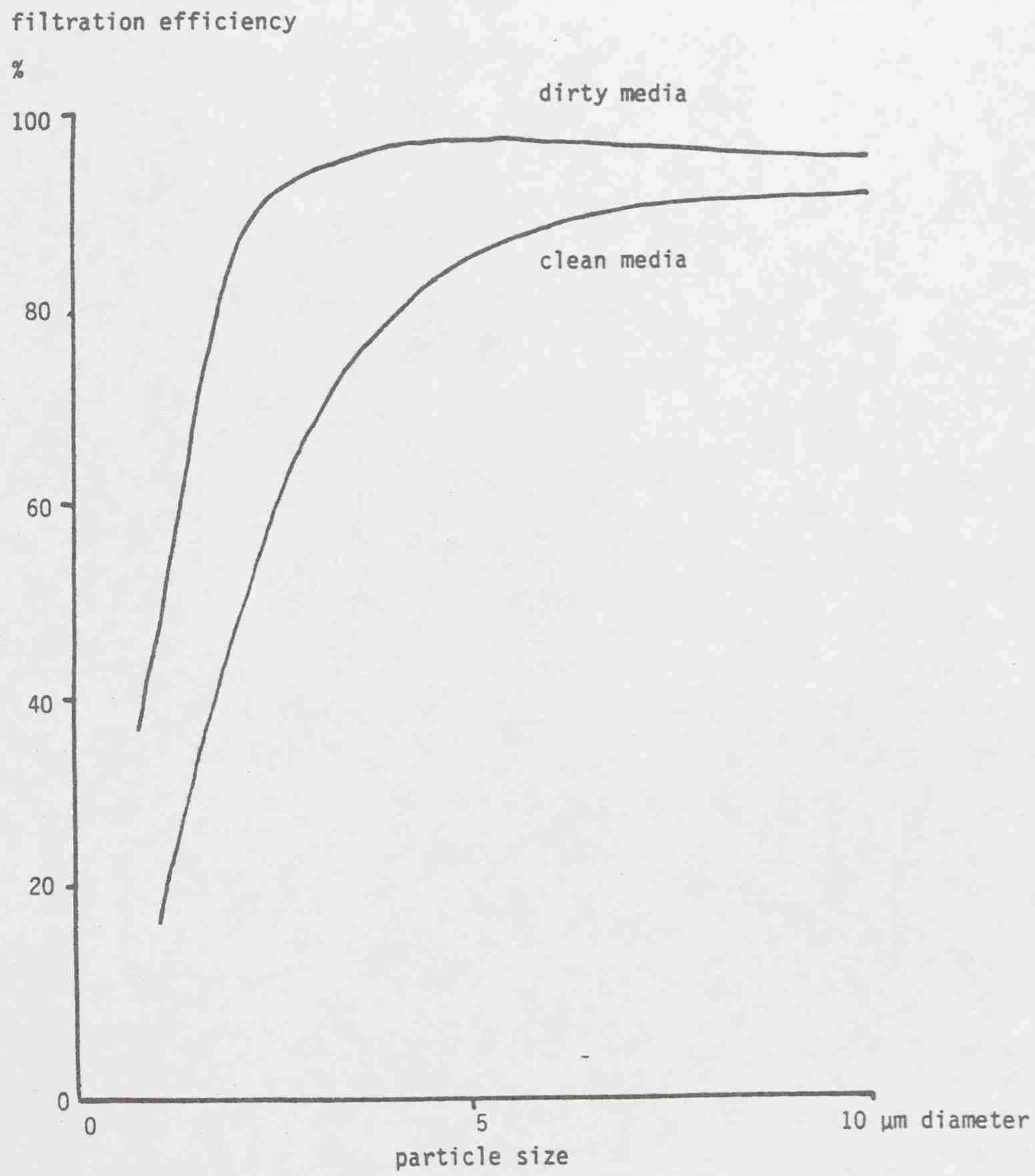


Fig. 11 Filtration efficiency as a function of particle size
(AAF Rollomatic - face velocity 2.5 m/s)

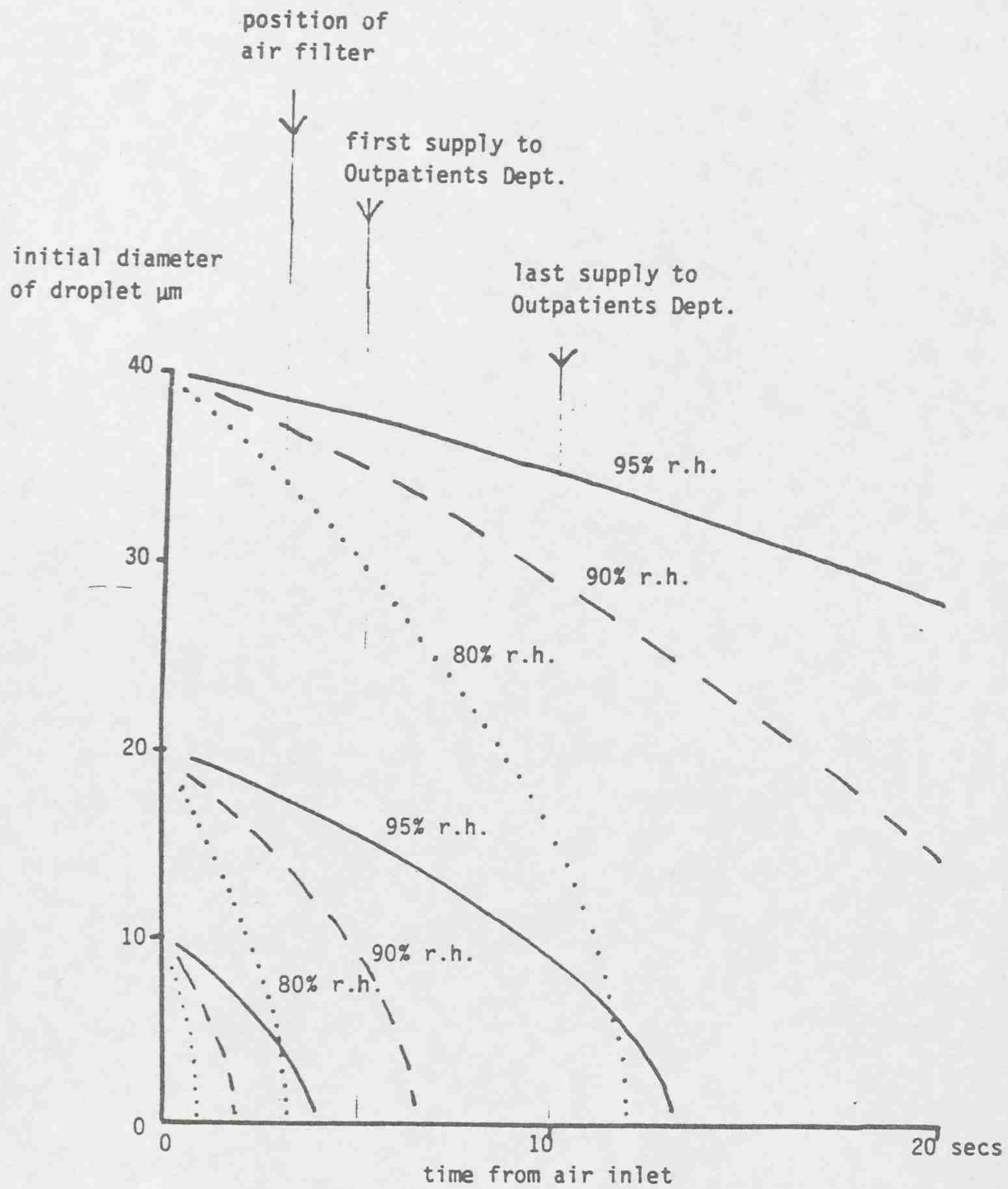


Fig. 12 Change in droplet diameter as a function of time and ambient r.h. (air temperature 10°C: data from Dr. D.J. Moore, CERL Laboratories; average residence time of air in waiting room 10 minutes)

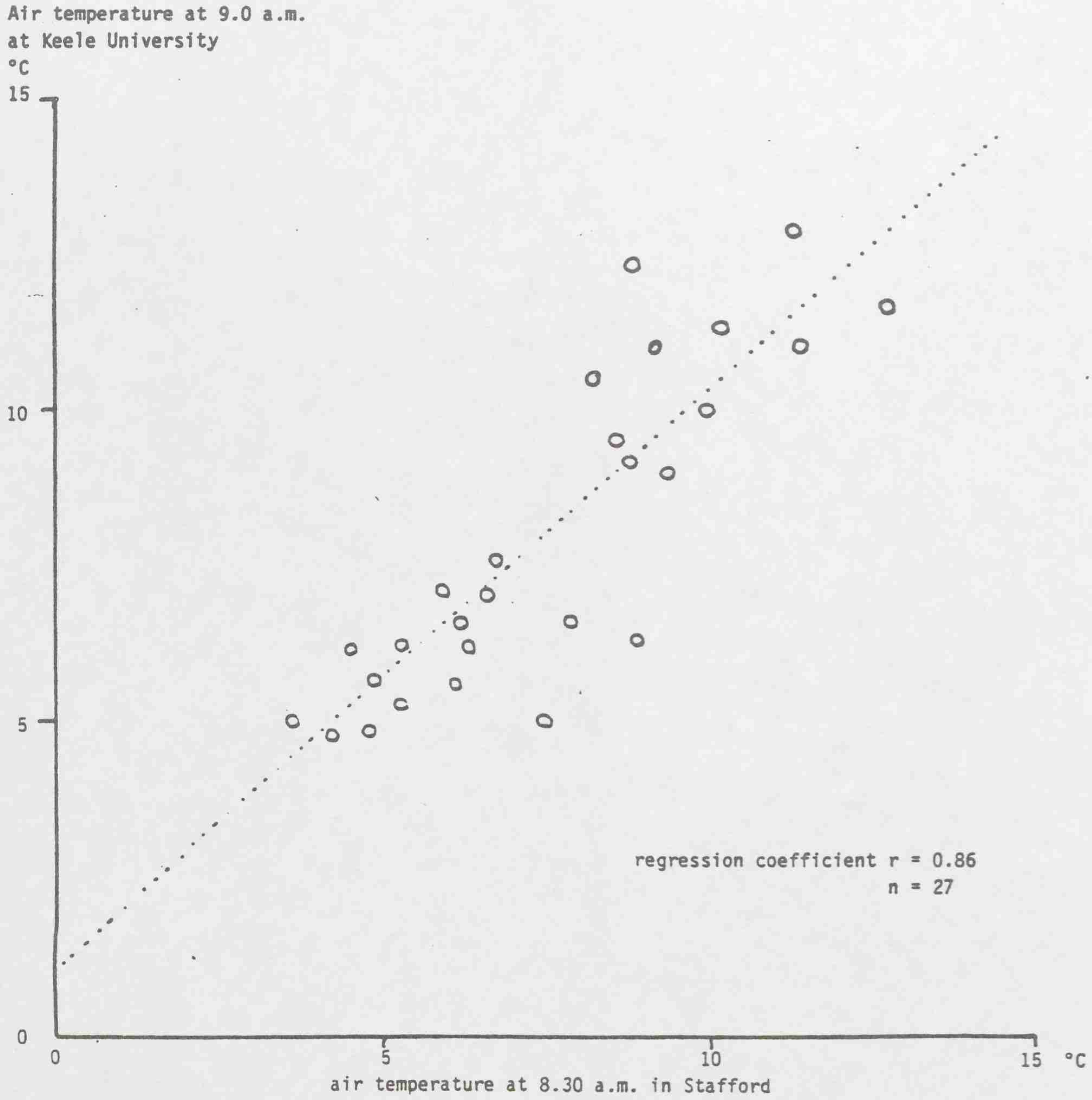


Fig. 13 Relationship between morning air temperature at Stafford and Keele for the month of April 1985

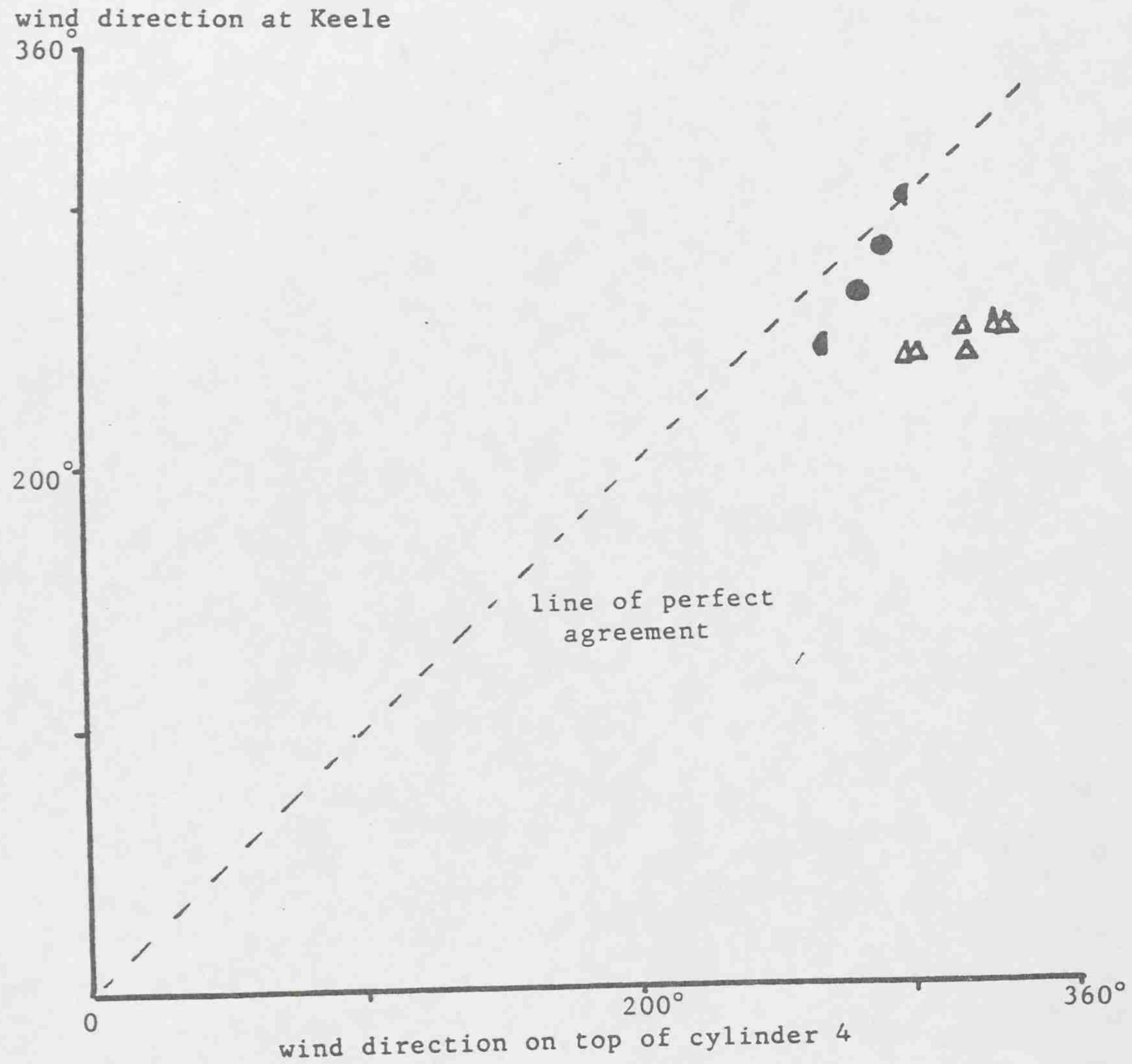


Fig. 14 Comparison of wind direction recorded at the top of Cylinder 4 with that recorded at Keele

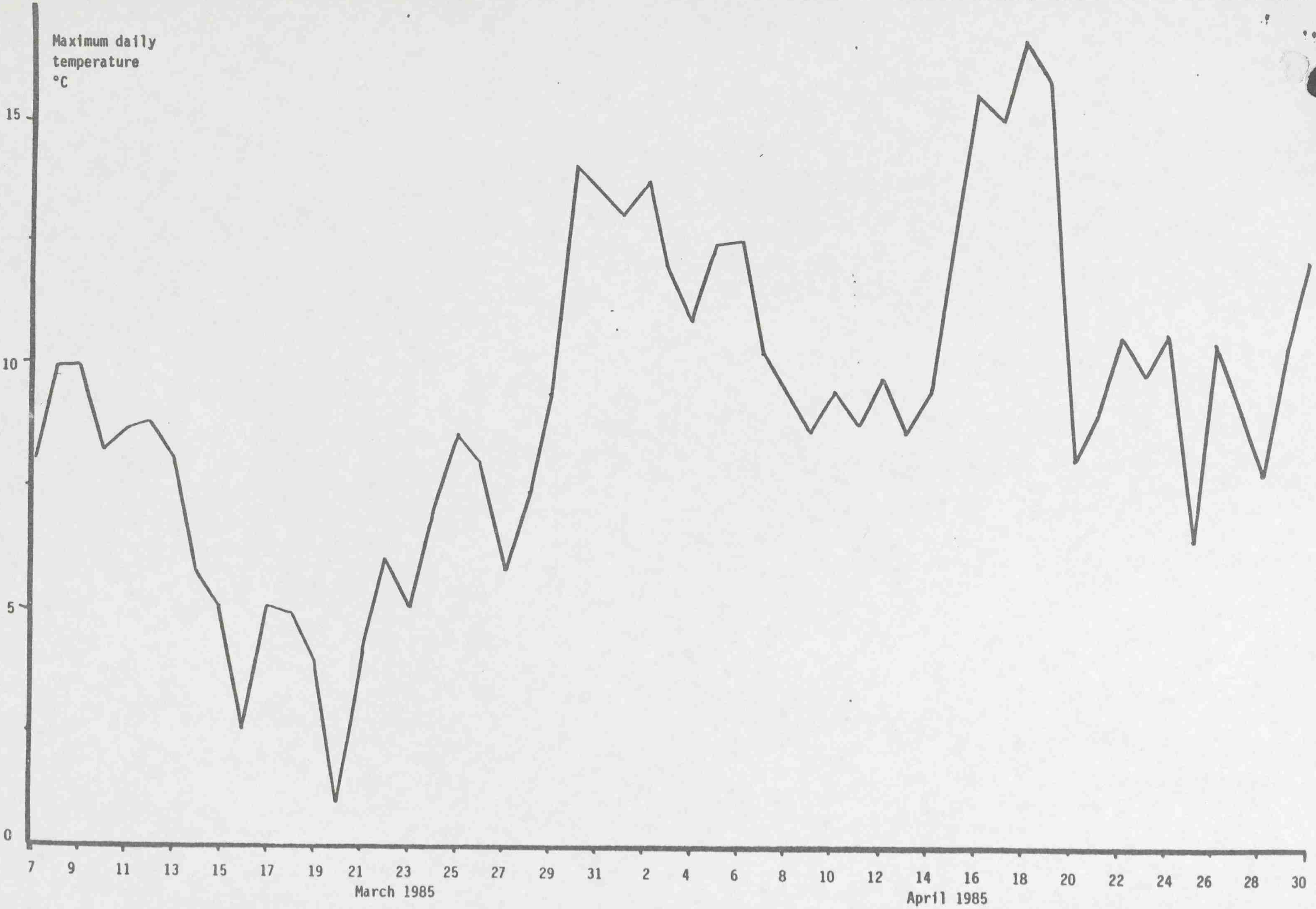


Fig. 15 Maximum daily temperatures at Keele University

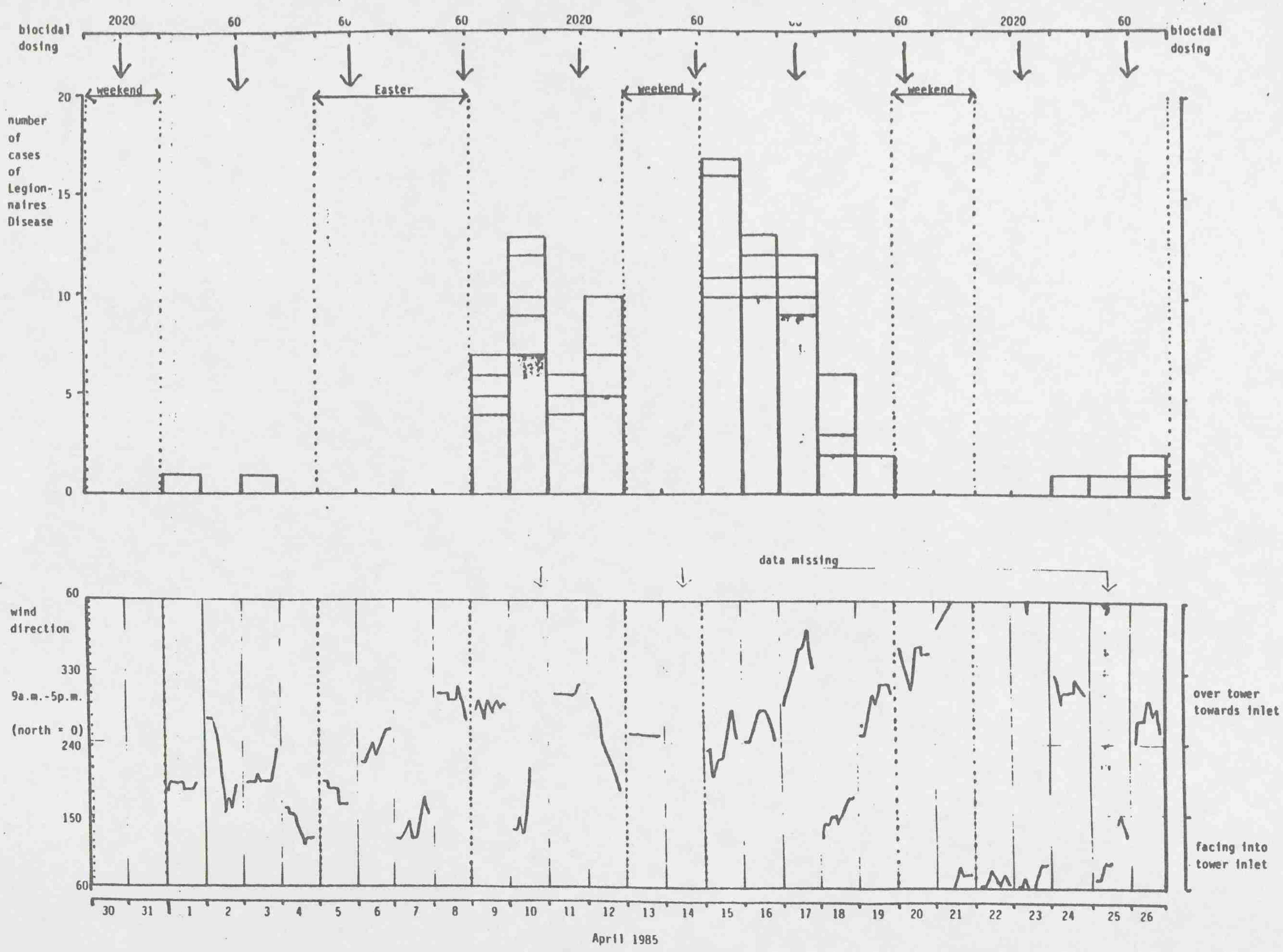


Fig. 16 Relationship between wind direction and infection rate

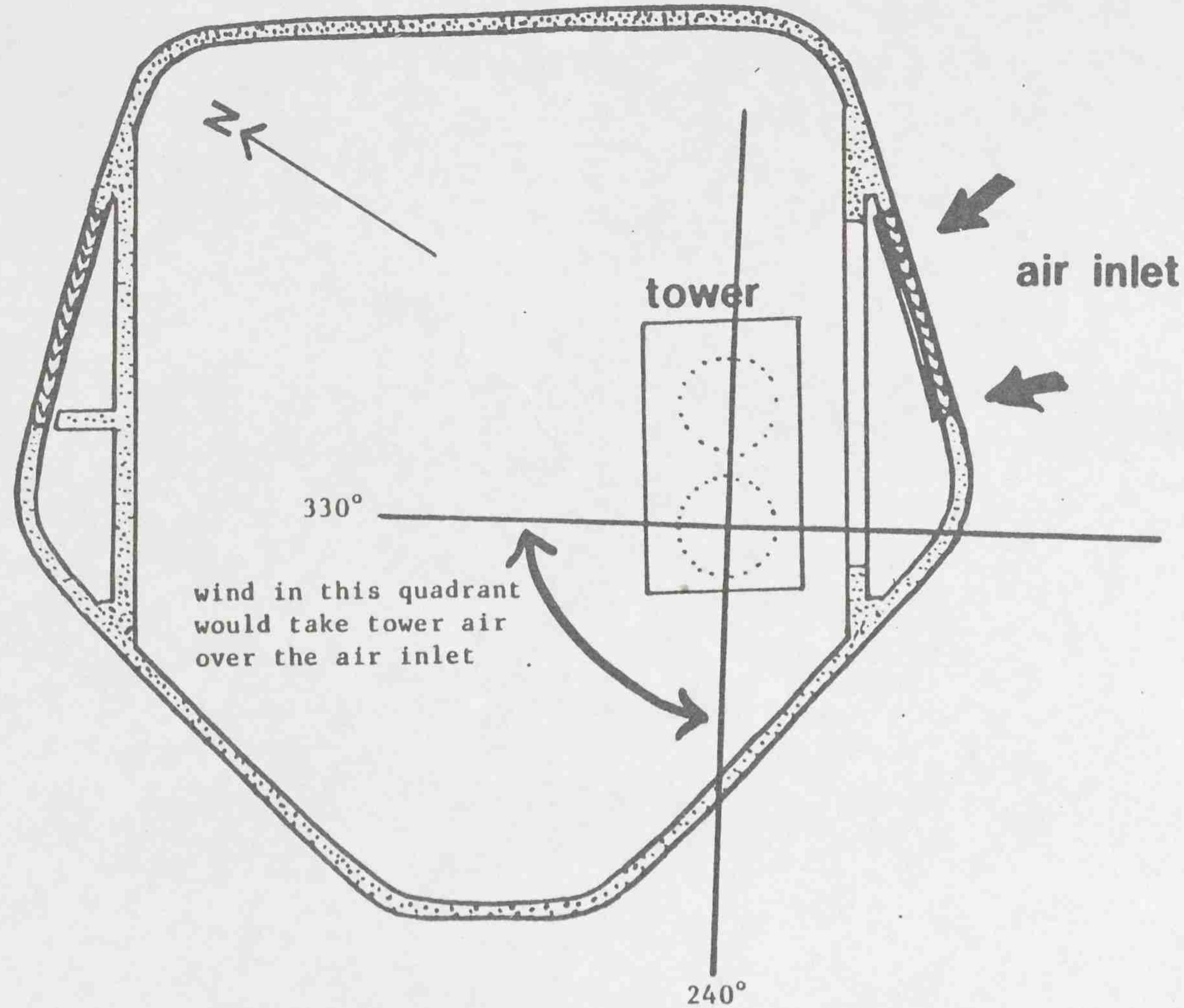


Fig. 17 Orientation of Cylinder 4 cooling tower and air inlet

MB

Prime Minister
Content?
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DEPARTMENT OF HEALTH & SOCIAL SECURITY
Alexander Fleming House, Elephant & Castle, London SE1 6BY
Telephone 01-407 5522
From the Minister for Health

The Rt Hon The Lord Hailsham
of St Marylebone CM FRS DCL
Lord Chancellor
House of Lords
LONDON SW1

20 May 1985

Dear Quintin,

OUTBREAK OF LEGIONNAIRE'S DISEASE IN STAFFORDSHIRE

As you know, we have been giving some thought to the form of the proposed Inquiry into the outbreak of Legionnaire's Disease in Staffordshire. The considerations we have had in mind are:-

a. the essentially medical and technical nature of the issues to be explored;

b. the need to take account of the implications of the findings for the NHS and elsewhere.

I have concluded that there should be a wide-ranging public inquiry under Section 84 of the NHS Act 1977 and Section 70 of the Public Health (Control of Diseases) Act 1984. In my opinion, an eminent medical practitioner should be chairman. Sir John Badenoch DM, FRCP, Honarary Consultant Physician, Oxford HealthAuthority and Chairman of the Joint Committee on Vaccination and Immunisation, has said he is willing to take this on. Other members would include a microbiologist, an engineer, a DHA Chairman and a lawyer.

The terms of reference would be as follows:-

> "To inquire into the cause of the recent outbreak of Legionnaire's Disease in Staffordshire;
>
> to consider the adequacy of measures taken to investigate and to deal with the outbreak;
>
> to report to the Secretary of State for Social Services and make recommendations on any action necessary to reduce the danger of future outbreaks originating in hospitals, other buildings and elsewhere."

These will enable a very wide-ranging inquiry to be held, and the inquiry will be free to make interim recommendations on any matter as its work proceeds.

E.R.

We propose that the terms of reference and names of members should be announced on Wednesday 22 May by PQ and Press Release. We are alrady sounding out suitable doctors and DHA Chairmen; with Department of Environment we are considering a possible engineer and I know your Department is considering the legal membership.

If you or any other recipients of this letter have any comments on what is proposed, would you please let me have them urgently. Copies of this letter go to colleagues in Scotland, Wales, N Ireland, at Treasury, DoE, Energy, DTI, DES, MAFF, Home Office, Attorney General, Treasury Solicitor and to Number 10.

Yours,

Ken

KENNETH CLARKE