Scottish Health Technical Memorandum 2009

(Part 1 of 2)

Overview and management responsibilities

Pneumatic air tube transport systems

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Contents

1. Introduction

1.1 Hospital departments are coming under increasing pressure to examine how capital investment projects can be used to improve efficiency in both the provision of services and the use of manpower. Automated transport systems such as pneumatic air tube transport systems have begun to feature prominently in the capital plans of hospitals, and in particular pathology departments, throughout the United Kingdom and abroad as a cost-effective method of improving the quality of service to their customers.

1.2 Pneumatic air tube transport systems provide an efficient, rapid and secure means of transporting various items such as blood and tissue samples, drugs, X-ray films and documents from one department to another. The speed of the system (up to 6 metres per second) considerably reduces the length of time patients and staff have to wait for results. This can often be a major factor in the decision to install a pneumatic communication system.

1.3 In addition to improving turnaround times, pneumatic air tube transport systems also promote a more effective use of ward-based and messenger staff by reducing the amount of time staff spend physically transporting items from one location to another. Nursing staff are therefore able to spend more time with the patient.

1.4 The installation of a pneumatic air tube transport system must be consistent with the overall communications policy of the hospital since it will form an integral part of the information technology network. The physical movement of items through the pneumatic transport system will be recorded electronically via computerised requesting stations located in wards and departments.

1.5 The sophistication and flexibility of pneumatic air tube transport systems means that each individual installation can be tailored to meet the specific requirements of the customer.

1.6 This Scottish Health Technical Memorandum (SHTM) is equally applicable to both new and existing sites. It gives advice and guidance to health care management, design engineers, estates management and operations managers on the legal requirements, design implications, maintenance and operation of pneumatic air tube transport systems in healthcare premises.

1.7 Current statutory legislation requires both management and staff to be aware of their collective responsibility.

2. Management responsibilities

Statutory requirements

Introduction

2.1 So far as pneumatic air tube transport systems are concerned, the chief areas of legislation with which managers should be familiar are health and safety and operator protection.

Health and Safety at Work etc Act 1974

2.2 The largest and most important body of law to be considered by management teams is the Health and Safety at Work etc Act 1974 (the HSW Act) and its various regulations.

2.3 The HSW Act and its regulations require employers to assess the risks to their employees. Attention is drawn to the following with respect to pneumatic air tube transport systems:

a. the stored energy hazards associated with transport systems;

b. the infection hazard associated with the microbial pathogens that may be handled by personnel;

c. the hazard of infection to patients and staff by the inadvertent release of a load;

d. the hazards associated with the handling of medical samples while loading and unloading;

e. the hazards associated with radioactivity.

2.4 The guidance given throughout this SHTM is designed to ensure that these hazards are minimised and that all procedures comply with the relevant legislation and established good practice.

Management of Health and Safety at Work Regulations 1999

2.5 The Management of Health and Safety at Work Regulations 1999 expand upon the principles of the HSW Act.

2.6 The core of the Regulations is a requirement of employers to make a systematic assessment of the risks to health and safety to their employees and others arising from work activities.

Workplace (Health and Safety and Welfare) Regulations 1992

2.7 Most of the Regulations deal with the physical requirements of the workplace. Managers concerned with the operation of pneumatic air transfer systems should pay particular attention to the Regulations on maintenance, temperature, cleanliness, room dimensions and space, and traffic routes.

Provision and Use of Work Equipment Regulations 1998

2.8 The Provision and Use of Work Equipment Regulations 1998 (SI 1998/2306) aim to ensure the provision of safe work equipment and its safe use.

Pressure Systems Safety Regulations 2000

2.9 The Regulations on pressure systems apply to pneumatic air tube transport systems operating above 0.5 bar.

2.10 The Regulations also define the competent person: “a competent individual person (other than an employee) or a competent body of persons corporate or unincorporate”.

Control of Substances Hazardous to Health Regulations 1999

2.11 The Control of Substances Hazardous to Health (COSHH) Regulations 1999 (SI 1999/437) impose duties on employers to protect employees and other persons who may be exposed to substances hazardous to health and also impose certain duties on employees.

2.12 Users of pneumatic air tube transport systems should note that a “substance hazardous to health” may include a micro-organism which creates a hazard to the health of any person. Guidance on the precautions to be taken when handling micro-organisms may be found in the HSC documents, *Categorisation of pathogens according to hazard and categories of containment*, (second edition 1990), compiled by the Advisory Committee on Dangerous Pathogens, and *Safe working and the prevention of infection in clinical laboratories*, compiled by the Health Services Advisory Committee. Reference should also be made to the Scottish Executive Health Department, Advisory Group on Infection, Scottish Infection Manual, Guidance on core standards for the control of infection, in hospitals, healthcare premises and at the community interface.

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

2.13 Commonly known as RIDDOR, they impose duties on persons responsible for the activities of persons at work and on self-employed persons to report accidents resulting in death or major injury arising out of, or in connection with, work and to report specified dangerous occurrences. They also require certain particulars of accidents at work to be reported both to the Department of Health and also to the Health and Safety Executive, and require records to be kept.

Manual Handling Operations Regulations 1992

2.14 The Regulations require employers to make an ergonomic assessment of all manual handling operations which involve a risk of injury, and to reduce the risk as far as reasonably practical. Factors to be assessed include the nature of the task, the load, the working environment and individual capability.

2.15 Managers should assess the risks associated with loading and unloading samples transported in the system.

Personal Protective Equipment at Work Regulations 1992

2.16 Managers should assess whether the risks associated with pneumatic air tube transport systems require the use of personal protective equipment.

Electromagnetic Compatibility Regulations 1992

2.17 The Electromagnetic Compatibility Regulations 1992 (amended 1994) impose requirements concerning the electromagnetic compatibility of most types of electrical and electronic apparatus which must be complied with when such apparatus is to be supplied or taken into service.

2.18 A pneumatic air tube transport system (and any ancillary equipment) is a “relevant apparatus” within the terms of the Regulations, and will have to meet standards for emission of and immunity to electromagnetic disturbance.

2.19 The Regulations do not apply to any pneumatic air tube transport system supplied or taken into service in the EC before 28 October 1992. A pneumatic air tube transport system supplied or taken into service in the UK on or before 31 December 1995 is not required to comply with the Regulations provided it complies with the requirements of the Wireless Telegraphy Acts listed in Schedule 1 of the Regulations.

NOTE: Detailed guidance on the application of the EMC Regulations in healthcare premises may be found in SHTM 2014; *Abatement of electrical interference*.

2.20 Electrical supply and distribution services, including all manufactured equipment, must comply with the following legislation in all or in part as applicable:

a. the Electricity Act 1989;

b. the Electricity Supply Regulation 1988 (as amended 1994). These impose requirements regarding the installation and use of electric lines and apparatus of suppliers of electricity, including provisions for connections with earth. These regulations are administered by the Engineering Inspectorate of the Electrical Division of the Department of Energy and may impose requirements which are additional to those of the Electricity at Work Regulations;

c. the Electricity at Work Regulations 1989. The principal statutory requirements for electrical safety in the workplace are the Electricity at Work Regulations 1989 (SI No 1989/635). The Regulations came into force on the 1 April 1990. The purpose of the Regulations is to require precautions to be taken against the risk of death or personal injury from electricity in work activities.

Other responsibilities

2.21 Management has a general responsibility to ensure that the pneumatic air tube transport system is operated at a standard suitable for the purpose for which it was installed.

2.22 The transportation of drugs within the system should be controlled by a procedure which provides secure means of transfer of the drugs between the pharmacy and hospital stations.

2.23 The transportation of samples within the system should be governed by a management quality procedure covering the precautions and handling procedures to be undertaken by staff using the system. A list of items not to be transported in the system should be displayed at all workstations.

2.24 The Construction (Design and Management) Regulations 1994 place duties upon clients, designers and contractors to rethink their approach to Health and Safety so that it is taken into account and then co-ordinated and managed effectively throughout all stages of a construction project from conception, design and planning through to execution of works on site and subsequent maintenance and repair.

3. Functional overview

3.1 A pneumatic air tube transport system, which may be either a “point to point” or a multi-point system, is a distribution network of tubes through which carriers of various sizes containing small items are driven by air flow. The prime mover is a blower which can alter the direction of the air flow in the tube as required to move the carrier through the system. The destination of the carrier may be controlled by diverters which switch the carrier from one branch to another. A central controller ensures that carriers are routed through the network.

Types of system

Point to point

3.2 Point to point pneumatic air tube transport systems (see Figure 1) provide two-way transfer between points via a single continuous tube linking two points up to 1000 metres apart. The systems may be suitable for use in an application which requires simple operation and a dedicated link between departments, for example between an operating theatre and the pathology department.

Multi-point

3.3 Multi-point air tube systems (see Figure 2) provide full intercommunication between all stations in the network or zone. Where systems are large and traffic is heavy, the network may be split into zones. This allows local transport of carriers in each zone, as well as transfer to another zone, when required. This type of system is used in a large hospital, with, for example, the pathology and the pharmacy departments being in separate zones.

Tubing

3.4 The most widely used tube for hospital systems is uPVC of size 110 mm diameter; however, other sizes are available.

3.5 The tubing must have a large bending radius (650 mm to 800 mm) to allow the carriers to negotiate the bends and care is required in routing the tubing through the hospital. The majority of systems are fitted into existing hospitals where routes which can accommodate suitable tubing and the maximum bending radius are fairly limited. New build hospitals may take into account the space requirements for the tube systems during the design process, and allow greater flexibility in choosing a tube bending radius.

Blower

3.6 The blower size will be determined by the maximum carrier weight, tube diameter, length of tube and system operating velocity. In complex sites multi-zone systems are generally more practical.

Figure 1: Point-to-point system

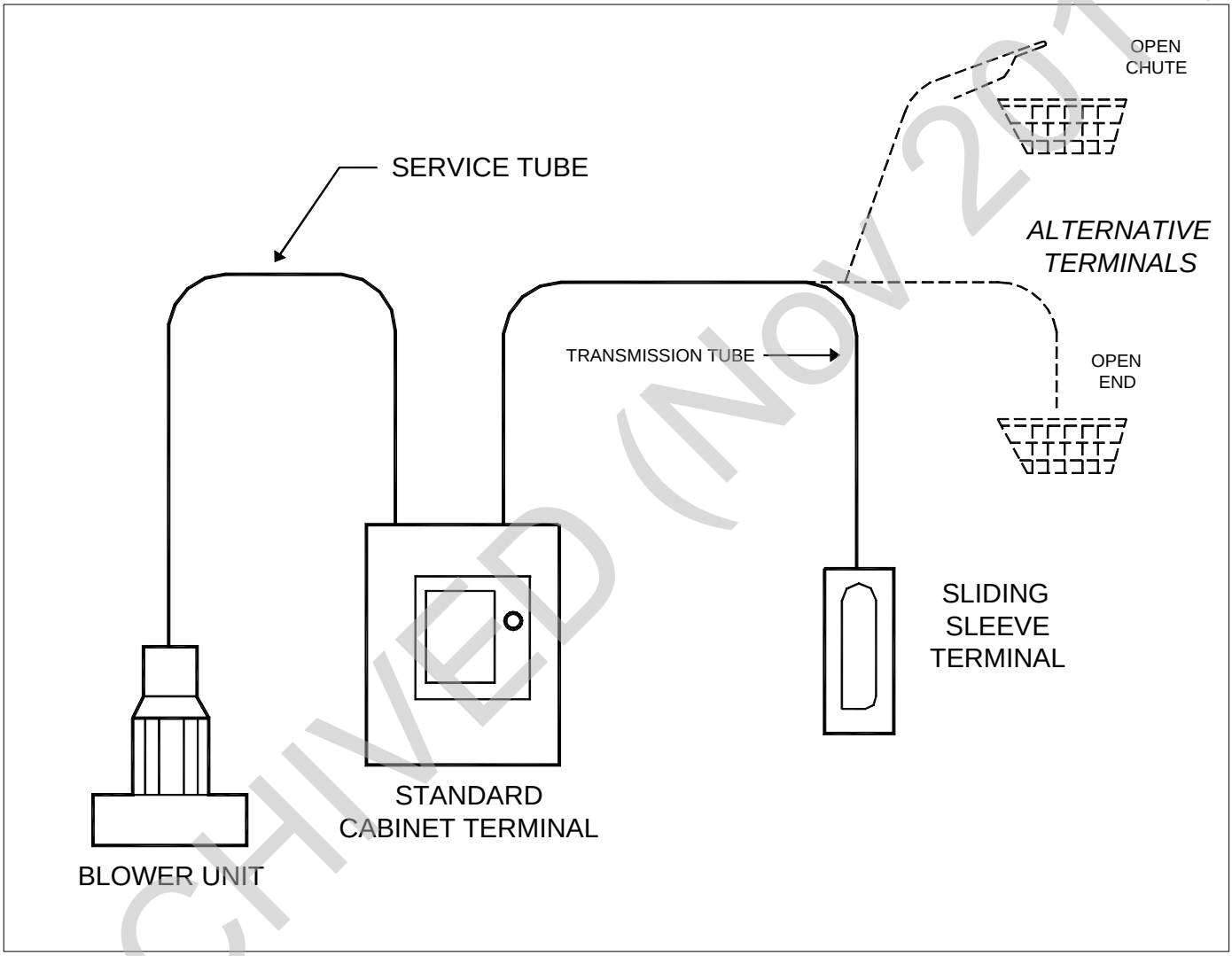
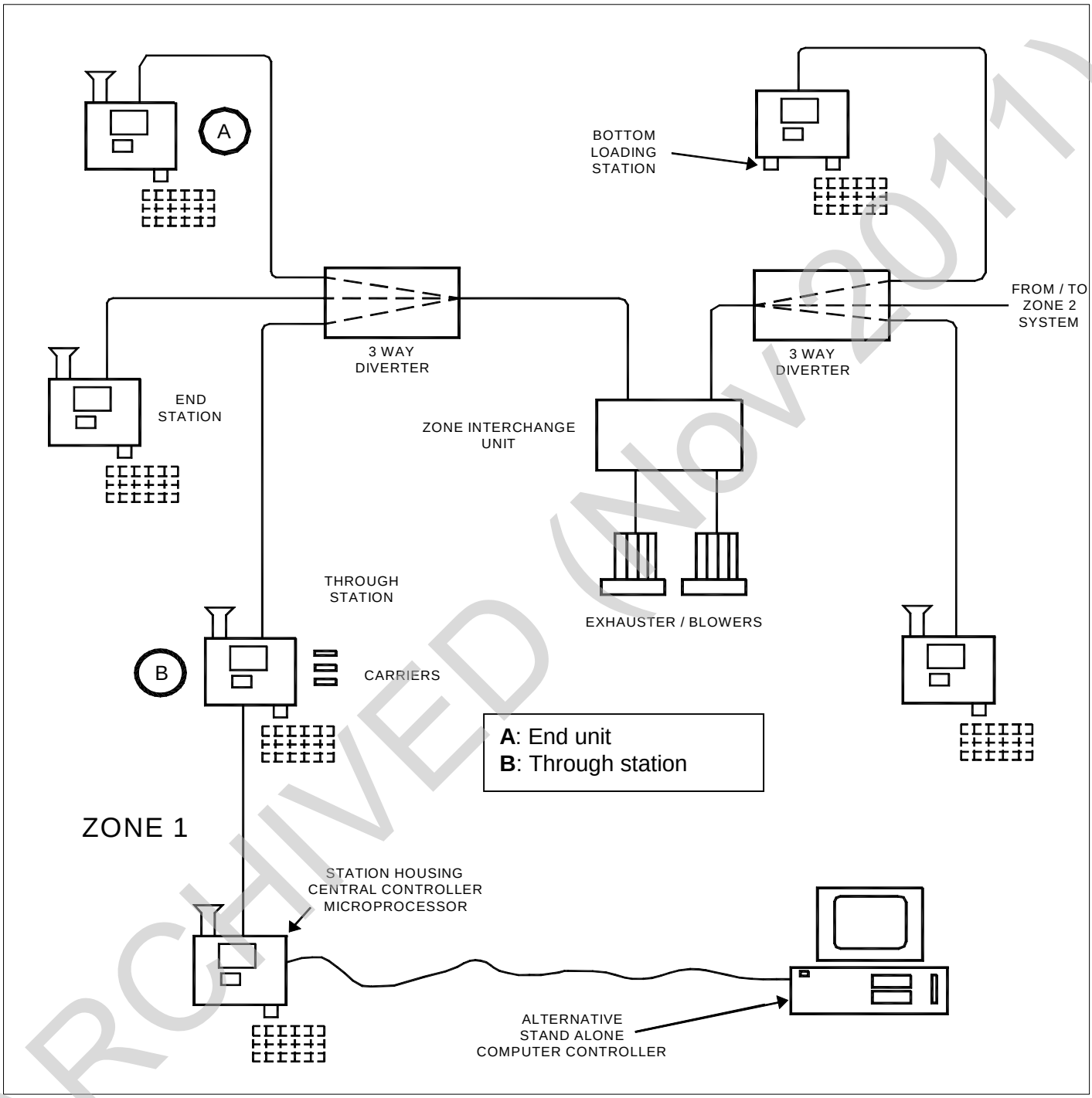


Figure 2: Multi-point system



Weight limits

3.7 Carriers can transport packages up to 1.5 kg although heavier packages may be conveyed if required subject to the manufacturer's recommendation.

System operation

3.8 The material to be transported is loaded into a carrier which is then placed in the tube at the send station. A destination station address is entered via a keypad and the carrier is then sent automatically through the network of transmission tubing to the destination. Although travelling at a speed of 5-6 metres per second, fragile items may be transported safely: carriers are accelerated gradually, and arrival at the destination is cushioned by a gentle braking system.

Travel times

3.9 The time taken from keying in the destination station to reception depends on the distance between the stations but will normally be one to three minutes, with a maximum of 15 minutes between stations in large systems.

3.10 The control transfer system determines the best possible route for carriers and automatically queues them for transmission at the earliest opportunity. The carrier journey time is normally much quicker than manual transfer, and the pneumatic air tube transport system provides an efficient means of transferring materials, without the need to use trained medical staff or porters.

3.11 Each receiving station may have a locked cabinet into which the carrier is deposited, a feature that is recommended when the system is used to transport prescription drugs.

3.12 If considered necessary, carriers may be specially labelled for use for specific items, such as drugs or pathology samples, or for a particular department to ensure that they are returned to the appropriate terminal as soon as possible. This may also serve to prevent any possibility of cross contamination from pathology samples being transported in the same carriers as pharmacy items. The use of sealed containers however may be considered adequate protection for the purpose.

Advantages and disadvantages

3.13 The advantages and disadvantages of pneumatic air tube transport systems may be summarised as follows:

Advantages

Faster turnround time for transported items;

Service available 24 hours a day;

Productivity savings allow more time to provide direct patient care;

Reduction in inter-departmental movements of staff;

Increased productivity and efficiency.

Disadvantages

Limited capacity (although majority of samples will be capable of transport in system);

Manual backup option required in event of system failure (pneumatic systems have proved reliable);

Risk of infection and cross-contamination (use of sealed container can minimise this risk);

Reduced security in transfer of drugs (controlled dispatch of drugs with code to release carrier).

The disadvantages may not be significant, as briefly outlined in brackets after each item.

Control system

3.14 The system should be controlled by a computer or microprocessor and should include the following functions:-

a. send/receive transaction between stations;
b. system self test;
c. system status information;
d. automatic purging cycle;
e. system software re-configuration;
f. continuous polling of all stations;
g. system send/receive priorities (urgent items);
h. forward address list (maintenance of stations);
i. manual control (receiving of carriers etc.);
j. system purge (push/pull facility);
k. PIN security system.

Optional features

3.15 The system may also incorporate some or all of the following features:

a. carrier storage: redistribution of carrier to other stations; redistribution of carrier to point of maximum deficit;

b. management status/traffic/alarm reports: print-out;

c. zoned network system: large installations;

d. visual/audible indication: to nominated/specific staff members;

e. pharmacy security drug transfer system: secure station to station transfer; high/low order destination; high = secure transaction; low = non-secure transaction.

General installation considerations

3.16 The following points should be considered before installing a pneumatic air tube transport system:

a. current volume of traffic between departments;

b. type of samples to be transported;

c. size of samples to establish carrier size most suitable. The carrier size will govern the radius of bends used in the installation. A list of carrier sizes is given in the 'Design considerations and Good practice guide' of this SHTM;

d. number of stations, their location and links. This will determine the system required, that is, point to point or multi-point network;

e. plantroom location(s) for blower(s) with 3-phase supply;

f. operational policy on security for drug transfer;

g. items that should not be transported in system;

h. system expandability.

The following brief notes illustrate how pneumatic air tube transport type of systems are used in various hospitals:

a. The Ayr Hospital operates a 150 mm diameter Pneumatic Tube system with two zones and 26 stations covering laboratory pharmacy, medical records and all wards in the hospital;

b. Bristol: a four station system provides a link for transferring drugs, blood and pathology samples between the maternity hospital and the Bristol Royal Infirmary, which are approximately 500 metres apart. The system is capable of transferring actual blood bags;

c. Royal Marsden Hospital, London: the system is used to transfer tissue samples direct from the operating theatre to the pathology laboratory for immediate analysis. The system has a High Efficiency Particulate Absolute (HEPA) filter through which all incoming air is drawn;

d. Cheltenham General Hospital: the hospital is served by a four-zone multi station system with the central control computer housed in the pathology department reception. The system has been extended and upgraded over a number of years and now has approximately 28 stations linking the majority of the departments and wards in the hospital.

4. The suitability of products to be transported

4.1 A survey carried out in 1987 indicated that there was no deterioration in the samples travelling at speeds of up to 15 metres per second. Other reports indicate that with samples travelling at speeds of 6 metres per second, no deterioration in sample quality can be detected. This is of particular importance when test analysis can be altered by haemolysis. In this context, however it should be noted that sample deterioration is generally caused by rapid acceleration and deceleration, not the speed with which the sample travels within the system. This is recognised by most manufacturers of pneumatic systems, who ensure gradual acceleration and deceleration with an air cushioned soft carrier arrival station.

4.2 The modern pneumatic air tube transport systems with velocity restricted to 5 metres per second for fragile samples and controlled deceleration have eliminated the sample problems identified with some early systems. A recent study clearly shows that all routine analyses in biochemistry and full blood counts in haematology show no significant difference when transported by pneumatic tube at 7.5 metres per second, when compared with paired samples from messenger delivery. A similar comparative study on blood gases was also performed and once again no significant difference could be identified in the results.

4.3 The use of the pneumatic air tube transport system for the delivery of microbiology samples including blood culture bottles, presents no problem in sample quality and improves the timeliness of specimen arrival; thus ensuring better cultural relativity between organism types.

4.4 It is also possible to send small histopathology samples providing care is taken to ensure sample containers are leak-proof.

4.5 Reports from the United States indicate that it is safe to transport blood products from the blood transfusion laboratory to the theatre using modern pneumatic air tube transport systems.

4.6 The items carried in a hospital system vary but generally include:

Pathology:

- blood samples;
- urine samples;
- culture swabs;
- stools;
- blood cultures;
- spinal fluids;
- frozen section;
- radioactive blood samples;
- laboratory test results (may also be sent via computer network).

Pharmacy:

- intravenous 500 ml to 1000 ml with admixtures;
- protein based drugs;
- general pharmaceutical;
- patient TTD drugs;
- controlled drugs;
- aerosol medications;
- cytotoxic drugs (in prepared syringes).

General:

- samples;
- surgical instruments;
- X-ray films;
- medical records;
- menu cards.

5. Security

5.1 The need for security must be carefully weighed against the need for rapid access to the system, especially in an emergency situation when time delays can play a crucial part in patient outcome. As a general rule the send/receive stations should be located in an area away from the public, but in a convenient location for staff use. This could be, for example, inside a ward or theatre cluster where access can be restricted. The baskets may be lockable with the key under the control of the nursing staff.

5.2 The system can also provide varying degrees of security from a simple lockable send/receive station to security coded access.

5.3 The facility to isolate stations from the system is available on most systems. This has advantages if areas are to be left unattended for predefined periods, or for system maintenance.

5.4 It is generally more secure for samples to be delivered directly from point to point using pneumatic air tube transport systems, rather than by a messenger service. The number of lost and mislaid samples is reduced under the pneumatic air tube transport system.

6. Use of pneumatic tubes by pathology

General

6.1 Pathology laboratories are coming under pressure to review the delivery of their services to customers. This is a result of increased financial pressure from within their own organisations and commercial competition from external organisations. Another significant factor is the debate centred around the need for patient-focused care and whether or not there is still a requirement for a central hospital laboratory on site or whether sample testing can be devolved to clinical areas. The key factor in this discussion is the turnaround time for results, which requires the strategic management of the test process. The test process comprises three elements:

a. **pre-analytical phase:**

test ordering;*

venepuncture;

specimen identification;

specimen transportation;*

laboratory reception;*

b. **analytical phase:**

sample preparation and analysis;

c. **post-analytical phase:**

result interpretation;

transfer of result to clinician/requester.*

*areas where pneumatic tube communications can improve efficiency and thus competitive advantage.

Reasons for improved efficiency

Test ordering

6.2 The effectiveness of the venesection service can be greatly improved if the laboratory manager knows, prior to deploying venesection staff, what demands any individual customer is likely to make that day. This can be achieved by wards and departments sending their requests for venesection early in the morning via the pneumatic air tube transport system to a central point, thus enabling the laboratory to send the correct number of venesectors to any area, and thus maximising the use of its resources.

Specimen transportation

6.3 The timeliness of specimen delivery to the laboratory is greatly improved as samples can be despatched to the laboratory immediately after being taken, or in batches as each individual area is completed. This enables venesectors to continue taking samples on the ward, whilst enabling the laboratory to spread its workload, as it has a constant supply of samples. It also dispenses with the large batch of samples that puts unnecessary pressure on the analytical system for short periods of time, whilst leaving expensive capital equipment under utilised for long periods. Considerable time delays can also occur when medical and nursing staff take samples outside the normal venesection service times unless there is an effective way of getting samples to the laboratory. This often involves urgent specimens in an “out of hours” situation when staffing numbers are at a minimum and work pressures are at their highest. A recent survey at one hospital indicated that up to 64% of staff delivering samples to the laboratory were ward based and that 52% of samples took between one and two hours to arrive at the laboratory. The subsequent installation of a pneumatic air tube transport system at strategic points throughout the hospital virtually eliminated sample delivery by ward staff and significantly reduced the time delay in samples reaching the laboratory. The consequences were greatly reduced result turnaround time, better patient care on the wards and a general improvement in the use of valuable resources.

Laboratory reception

6.4 Once a sample has arrived in the laboratory main reception, there is often a delay in the sample being forwarded to the appropriate department for analysis. The installation of a dedicated pneumatic air tube transport system between the main laboratory reception and individual departments can radically reduce this bottle neck.

Transfer of results to clinician/requester

6.5 Once samples have been analysed, and the results authorised and printed, delays can often occur in the despatch of results to the clinician/requester via the traditional hospital messenger service. The use of an air tube transport system can greatly reduce transfer times.

References

NOTE:
Where there is a requirement to address a listed reference, care should be taken to ensure that all amendments following the date of issue are included.

Publication ID	*Title*	*Publisher*	*Date*	*Notes*
Acts and Regulations				
	The Building (Scotland) Act	HMSO	1959	
	Clean Air Act	HMSO	1993	
	Electricity Act	HMSO	1989	
	Health and Safety at Work etc Act	HMSO	1974	
	Registered Establishments (Scotland) Act	HMSO	1998	
	The Water (Scotland) Act	HMSO	1980	
SI 2179 & 187	The Building Standards (Scotland) Regulations (as amended)	HMSO	1990	
	The Building Standards (Scotland) Regulations: Technical Standards Guidance	HMSO	1998	
SI 2092	Carriage of Dangerous Goods (Classification, Packaging & Labelling) and Use of Transportable Pressure Receptacles Regulations	HMSO	1996	
SI 1460	Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP2)	HMSO	1997	
SI 3140	Construction (Design and Management) Regulations	HMSO	1994	
SI 437	Control of Substances Hazardous to Health Regulations (COSHH)	HMSO	1999	
SI 635	Electricity at Work Regulations	HMSO	1989	
SI 1057	Electricity Supply Regulations (as amended)	HMSO	1988 (amd. 1994)	
SI 2372	Electromagnetic Compatibility Regulations (as amended)	HMSO	1992	
SI 2451	Gas Safety (Installation and Use) Regulations	HMSO	1998	
SI 917	Health & Safety (First Aid) Regulations	HMSO	1981	
SI 682	Health & Safety Information for Employees Regulations	HMSO	1989	

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SI 2792	Health and Safety (Display Screen Equipment) Regulations	HMSO	1992	
SI 341	Health and Safety (Safety Signs and Signals) Regulations	HMSO	1996	
SI 1380	Health and Safety (Training for Employment) Regulations	HMSO	1990	
SI 2307	Lifting Operation and Lifting Equipment Regulations (LOLER)	HMSO	1998	
SI 3242	Management of Health and Safety at Work Regulations	HMSO	1999	
SI 2793	Manual Handling Operations Regulations	HMSO	1992	
SI 1790	Noise at Work Regulations	HMSO	1989	
SI 3139	Personal Protective Equipment (EC Directive) Regulations (as amended)	HMSO	1992	
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SHTM 2014	Abatement of electrical interference	P&EFEx	2001	CD-ROM
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SHTM 2023	Access and accommodation for engineering Services	P&EFEx	2001	CD-ROM
SHTM 2035	Mains Signalling	P&EFEx	2001	CD-ROM
SHPN 1	Health service building in Scotland	HMSO	1991	
SHPN 2	Hospital briefing and operational policy	HMSO	1993	
SHPN 48	Telecommunications	HMSO	1997	

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SHTN 1	Post commissioning documentation for health buildings in Scotland	HMSO	1993	
SHTN 4	General Purposes Estates and Functions Model Safety Permit-to-Work Systems	P&EFEx	2001	
	NHS in Scotland – PROCODE	P&EFEx	2001	Version 1.1
NHS in Scotland Firecode				
SHTM 81	Fire precautions in new hospitals	P&EFEx	1999	CD-ROM
SHTM 82	Alarm and detection systems	P&EFEx	1999	CD-ROM
SHTM 83	Fire safety in healthcare premises: general fire precautions	P&EFEx	1999	CD-ROM
SHTM 84	Fire safety in NHS residential care properties	P&EFEx	1999	CD-ROM
SHTM 85	Fire precautions in existing hospitals	P&EFEx	1999	CD-ROM
SHTM 86	Fire risk assessment in hospitals	P&EFEx	1999	CD-ROM
SHTM 87	Textiles and furniture	P&EFEx	1999	CD-ROM
SFPN 3	Escape bed lifts	P&EFEx	1999	CD-ROM
SFPN 4	Hospital main kitchens	P&EFEx	1999	CD-ROM
SFPN 5	Commercial enterprises on hospital premises	P&EFEx	1999	CD-ROM
SFPN 6	Arson prevention and control in NHS healthcare premises	P&EFEx	1999	CD-ROM
SFPN 7	Fire precautions in patient hotels	P&EFEx	1999	CD-ROM
SFPN 10	Laboratories on hospital premises	P&EFEx	1999	CD-ROM
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EH 40	HSE Occupational Exposure limits	HSE	Annual	
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