NHS National Services Scotland

Scottish Health Technical Memorandum 08-04:

Specialist services
Pneumatic tube transport systems
Part B: Design considerations and good practice guide

Health Facilities Scotland
Engineering and Environment

July 2015

Contents

Acknowledgements

This SHTM has been updated and expanded from SHTM 2009: Pneumatic tube transport systems, Part 2: Design considerations and good practice guide published by NHSScotland Property & Environment Form Executive (PEFEx) in June 2001, and now superseded.

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Preface

About Scottish Health Technical Memoranda

Engineering Scottish Health Technical Memoranda (SHTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

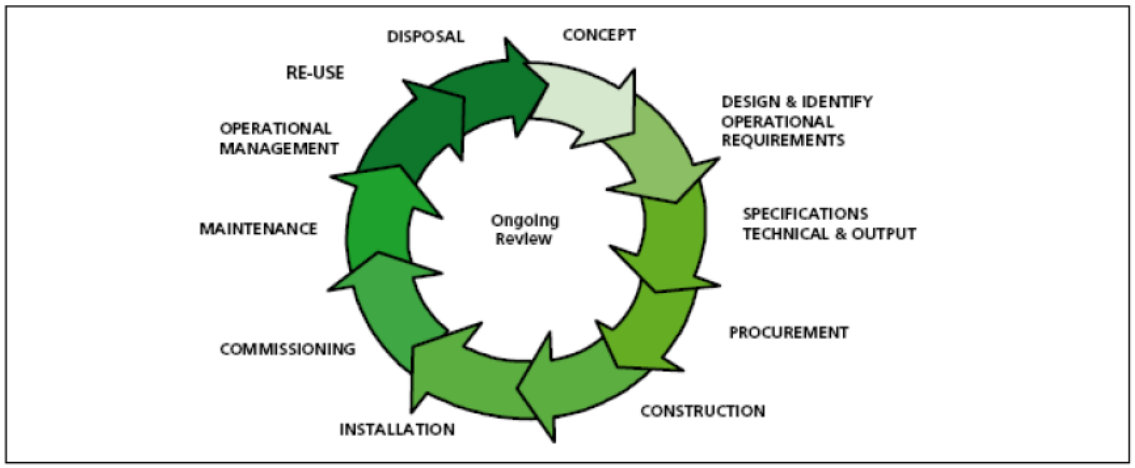
The focus of SHTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle: Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Scottish Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

It is not the intention within this suite of documents to repeat unnecessarily International or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of eight subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.



Healthcare building life-cycle

Structure of the Scottish Health Technical Memorandum suite

The series of engineering-specific guidance contains a suite of eight core subjects:

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Scottish Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water systems

Scottish Health Technical Memorandum 05: Reserved for future use

Scottish Health Technical Memorandum 06: Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

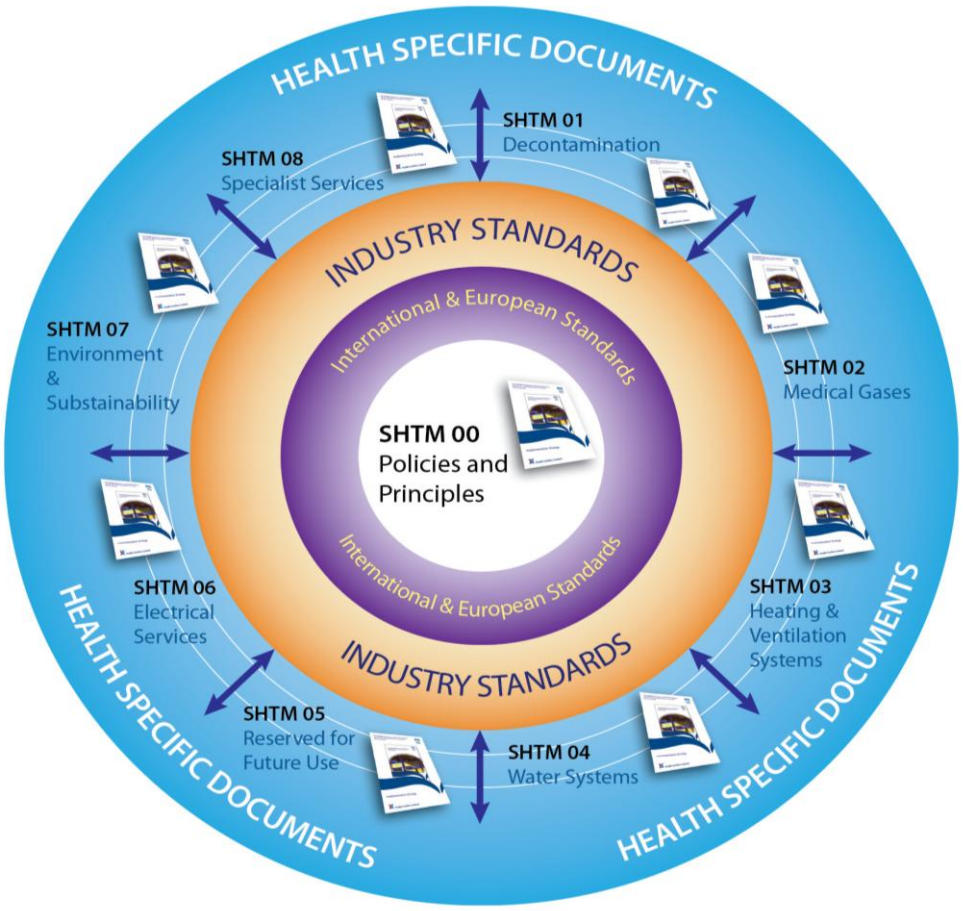
Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical safety guidance for low voltage systems.

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent: Environment and Sustainability – EnCO_2de.

All Scottish Health Technical Memoranda are supported by the initial document Scottish Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

Health Facilities Scotland wishes to acknowledge the contribution made by professional bodies, engineering consultants, healthcare specialists and NHS staff who have contributed to the review.



Engineering guidance structure

1. System overview

General

1.1 A pneumatic 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 an exhauster / blower assembly which can alter the direction of the air flow in the tube as required to move the carrier through the system. This is a specialist system that should preferably be maintained via a specific maintenance contract with the contractor who designed and installed it. This would apply irrespective of whether traditional procurement or PFI/PPP procurement applied.

Point-to-point system

1.2 Point-to-point pneumatic tube transport systems (see Figure 1 below) provide two-way transfer via a single continuous tube linking stations. These could be between adjacent locations or more than 1,000 metres apart. This system is suitable for use in an application that requires simple operation and a dedicated link between departments, for example between an accident & emergency unit and the pathology department.

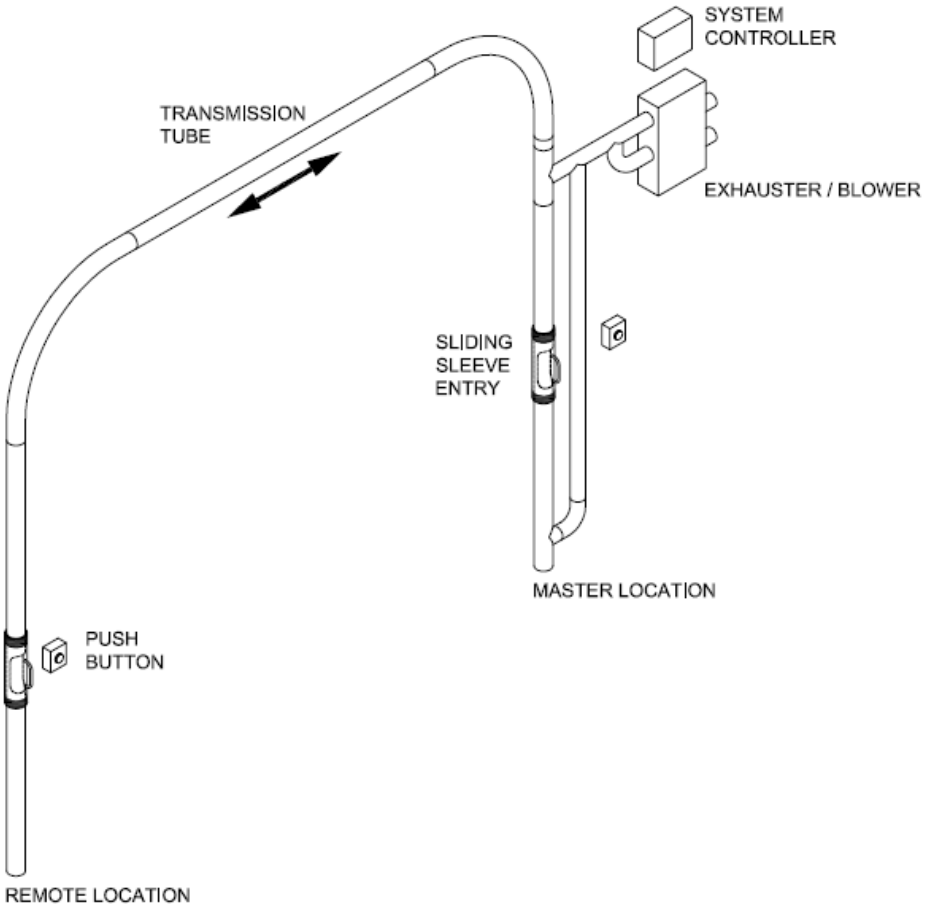


Figure 1: Typical point-to-point system

1.3 Multi-point pneumatic tube transport systems (see Figure 2, below) provide full intercommunication between all points in the system. Where systems are large and traffic is heavy, the network may be split into individual systems which may be referred to as zones. This allows local transport of carriers in each zone, as well as transfer to another zone when required. This type of system is commonly used in large hospitals, with, for example, the pharmacy and pathology departments being in separate zones. Differentiating colour coding of carriers may be employed to confirm the zones to which they belong provided this does not have a detrimental impact on flexibility of use. (Paragraph 2.9 also refers).

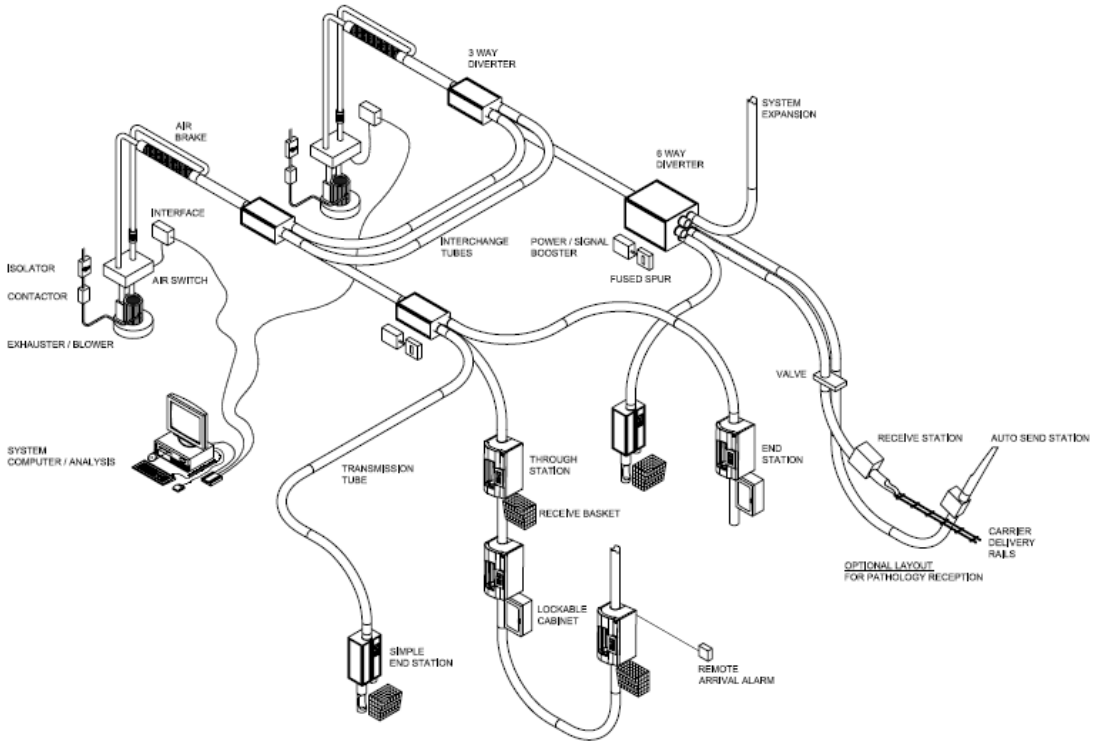


Figure 2: Typical layout of Pneumatic tube system incorporating interchange tubes

Diverters

1.4 Diverters are used to route carriers through the network and sometimes across zones. The number and location of diverters should be agreed at local level between the designer and hospital staff, but generally they should be used economically and be positioned to minimise the system tube length.

System control

1.5 Multi-point systems are controlled centrally by a dedicated microprocessor or computer. The controller receives transfer instructions, carries out continuous monitoring of the system and provides system status information. If required, cleaning cycles may be carried out at pre-determined intervals to keep the pipework free of dust. The control system should allow reconfiguration of the network as required. Stations can be operational on a 9.00 am to 5.00 pm basis, with override facilities as required, or 24 hours a day, according to the

requirements of a particular department. Remote access is a feature of the more comprehensive control systems which may be for simple information gathering or remote diagnostics. The specifying and design process should consider the requirements of modem or internet connections.

Stations

1.6 A station may be an end unit (one at the end of a branch), or a through station (carriers may pass straight through it). Although the stations operate in slightly different ways, send and receive operations may be carried out at each one. Each station should include a user interface, which is normally in the form of a keypad and display unit. Stations are addressed, generally, by a three-digit numerical code. Models include wall-mounting versions, counter-top versions and recessed type. The latter is unlikely to be accommodated within retrofit installations in existing hospitals.

1.7 Features of a typical hospital pneumatic tube transport system will include:

- network tubing: 160mm or 110mm diameter and normally PVC-U but, if required for protection, steel tube may be used for some sections;
- automatic send and receive stations;
- full intercommunication between all stations;
- prioritisation of carrier delivery;
- multi-zone with communication between systems/zones;
- security measures for the transfer of certain products, such as drugs;
- leak proof carriers (if justifiable) and/or sealed insert bags for samples (spillage may then be contained within carrier);
- tracking of carriers;
- soft carrier arrival.

2. Assessment of requirements

2.1 The cost of installing and maintaining a pneumatic tube transport system should be offset by the savings made in the time staff, and in particular portering staff, spend in the manual transfer of samples between departments. The decision to install a system should be made following an analysis of traffic in small items, including drugs and pathological samples, carried between departments by staff. The main users of the system in an acute hospital will normally be the pathology and pharmacy departments. Security measures will need to be incorporated into general operational procedures and consideration should be given to the location of stations in controlled access areas.

2.2 The results of the traffic survey will help to identify where stations should be allocated. Stations may be shared between departments to reduce the overall cost of the installation, for example one station for adjacent wards which are possibly already sharing facilities, provided there are no implications for compromising infection control.

2.3 The system should be capable of transferring packages safely and securely between all or only selected stations within the network which may cover a single hospital or a number of adjacent hospital sites.

2.4 A central controller should continuously poll all stations in sequence to initiate the required send/receive sequence for carriers loaded into stations. A system of send/receive priorities for each station ensures that urgent items are handled with minimum delay. A maximum time should be set to ensure carriers are not indefinitely parked in the system.

2.5 It should be possible to take manual control of the system to override the central control (with a sub-set of operations available at selected stations) to allow, for example, manual purging of the system in the event of a carrier becoming blocked.

2.6 Two separate purging procedures should be provided: system wide; and specific to a station to assist in recovering carriers suspended in the system, by setting the system to suck/blow carriers to the specified station.

2.7 Printed reports of status/alarms/traffic should be provided by the central controller as required.

2.8 For larger installations, the network will be faster and more efficient if it is split into individual systems that are served by an interchange. This will allow the majority of traffic to be directly transferred rather than double handled by the users.

2.9 Carriers can be Radio Carrier Identification (RCI) coded for each department. Identification of specific colour may be required by the infection control officer. Empty RCI coded carriers can be returned automatically to the relevant station.

RCI features are more commonly used for busy locations such as specimen reception.

Location of major system components

2.10 The exhauster/blower should be housed in a clean, ventilated, dust-free environment isolated from areas in which patients may be sleeping.

2.11 A filter might be required in the air intake to the system to protect samples or aseptic areas although it could only be coarse as careful consideration would be required to ensure that air movement for transporting carriers was not impeded. An alternative would comprise the use of a front-loading through station which would limit the release of air and could be installed to use or displace air into an area of lower risk or, indeed, outside. Planning teams should seek the advice of the infection control officer.

2.12 The station should be located in a secure area preferably only accessible to staff and which can be locked if the area is vacated. If a station is to be shared, access arrangements should be agreed and the security of the station assigned to one department.

2.13 Diverters should be located in service areas with good access for maintenance.

2.14 Tubing should be routed in roof spaces, ducts and ceiling voids if space is available. The tubing will require large bend radii and carriers are wasted to fit the curve radii. If the tube has to be routed externally or in hostile environments, it should be protected and insulated to reduce the risk of damage or condensation occurring within the pipework. Advice should be sought from the specialist to ensure that the best practice is adopted in routing the tube.

Safety

2.15 Access to areas that contain send/receive stations should be secured to prevent unauthorised entry, or provided with a lockable basket/cabinet.

2.16 Plant rooms containing pneumatic tube transport systems should be well-illuminated and should permit safe access to all parts of the plant requiring inspection, service and maintenance.

Security for drug transfer

2.17 The security system should be controlled from the pharmacy station.

2.18 Under normal operation, an arriving carrier is automatically released and deposited into the basket. Under the pharmacy security system this may be modified according to level of security selected by the despatcher in the pharmacy.

2.19 Consideration could be given to each station in the system having a unique code for receiving secure drug carriers. The entry of the code will signal to the central controller that the transaction must be secure. The carrier should not be discharged until the correct code has been entered at the receiving station. The

code should be set by the system manager. A station may require a number of security codes to enable individual control by departments sharing a station. Users should be aware that the sending station can no longer despatch to the receiving station until this carrier is removed.

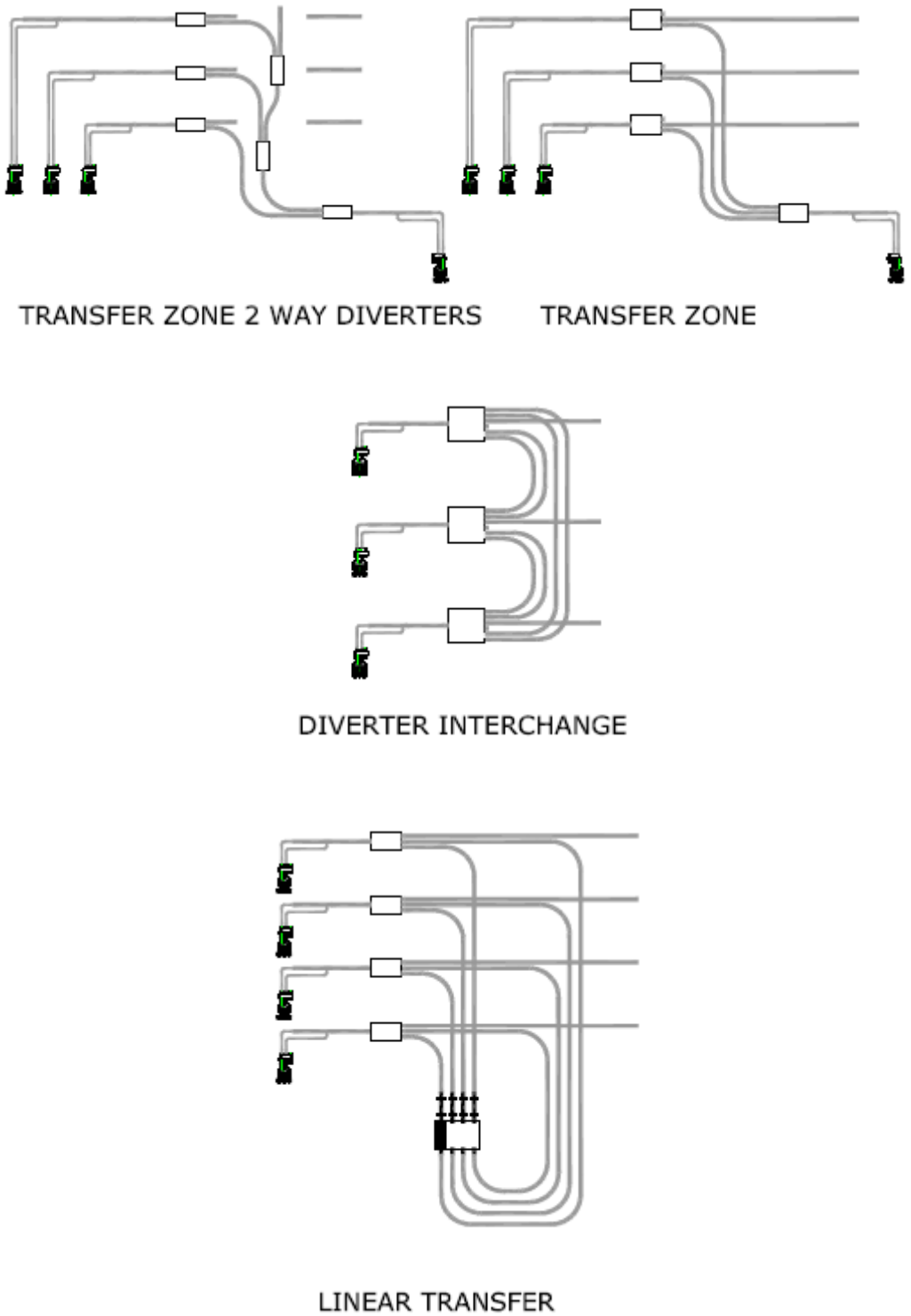


Figure 3: Typical Transfer, Diverter and Coupler arrangements

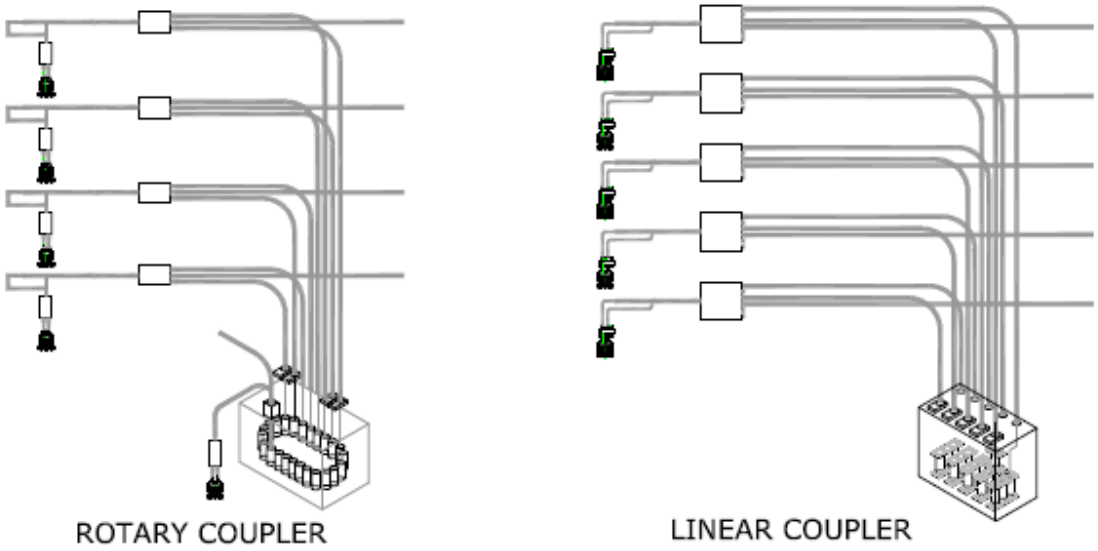


Figure 3 continued: Typical Transfer, Diverter and Coupler arrangements

3. Performance requirements

General

3.1 Equipment that requires regular inspection should not need to have its covers removed but instead should be arranged so that visual inspection can be carried out easily. The provision of viewing ports and good illumination of the components will facilitate this approach although the use of longer sections of Perspex or clear tubing can introduce unwanted higher static charges and attract more dust deposits.

Blower capacity

3.2 Exhauster/blower capacity should be established by the system designer and should be sufficient for transporting the carriers through the local zone at the agreed velocity and, if required, across to other zones connected in the network.

Tubing

3.3 The installation should normally be carried out using 160mm or 110mm diameter hard PVC-U tubing to DIN8061/62 Group B1 specification with all joints solvent welded. If certain sections of the system need to be protected, steel tubing should be used. If the option to specify 160mm tubing is taken, the need and ability to accommodate large radius bends will require careful consideration.

3.4 A smooth internal bore must be retained throughout the system.

3.5 Where tubing passes through a wall, floor, ceiling or other barrier, the contractor should ensure that the fire rating of the barrier is not reduced. This can be achieved by installing crushing type intumescent fire sleeves or collars. The system will require to be designed to take account of 'Cause and Effect' issues raised by Fire and Rescue Services in relation to shut-downs of zones local to the sources of fire alarm activation. Reference should be made to NHSScotland Firecode Guidance (SHTMs 81-86) for further information.

3.6 All tubing pipework should be labelled at regular intervals and each side of penetrations through walls, ceilings and floors to indicate its purpose.

Carrier velocity

3.7 The normal system speed is 5 m/s. System velocity should be agreed timeously with the pathology and pharmacy departments. The system should gradually accelerate and then slow down the carrier on arrival at the destination station.

Return carrier velocity

3.8 The majority of systems should operate satisfactorily using a velocity of 5 m/s having a network capacity or design for traffic to run at a safe speed for both

send and return carriers. Systems do offer selectable carrier speeds at individual stations should this be seen as essential for special applications.

Carrier braking

3.9 Carrier deceleration on arrival at the destination station should be carried out using the 'air column technique' in which an approaching carrier activates a pressure release device and is retarded by a still column of air above or below the station.

Note: Arrival from below provides safe control for soft arrival of carriers with worn rings.

Carrier arrival baskets/cabinets

3.10 Each station should be provided with a carrier arrival basket or cabinet of sufficient size and capacity to accommodate the number of carriers allotted to the appropriate station. The basket should be fixed to the wall or floor under the station and be positioned to allow carriers of an agreed number to arrive at the station and be stored within the basket without blocking the exit tube of the station. If the station is located in an area which may be unmanned or is accessible to the public, the basket or cabinet should be fitted with a lock and the key should be under controlled access. Alternatively, the use of manual coded locks may be used to avoid keys having to be held.

Carrier size

3.11 The carrier sizes available for a 110mm diameter tube usually having minimum bend radii of 800mm or as follows. The use of 650mm bends for 110mm tubing should be a last resort dictated by severe space limitations.

Carrier description			Transmission		Internal capacity	
Size	Type	Lid style	Nominal tube In mm	C/line bend radius mm	Diameter mm	Length mm
110	Short	Swivel top	110	800	80	228
110	Long	Swivel top	110	800	72	326
160	Short	Swivel top	160	800	116	350
160	Long	Swivel top	160	1200	116	420

Note: Long carriers (420mm long) require bends with centre line radius of 1,200mm.

3.12 A full survey over the proposed route of the tube will be required to establish the minimum bend radius that can practicably be used in the system. Pneumatic tube transport system suppliers should provide advice on the range of carriers suitable for the chosen bend radius.

Carrier design and provision

3.13 Leak-proof carriers should be specified as standard for all healthcare applications. A risk assessment would determine if there was a need for leak-proof carriers. They may be designed with one openable end or, alternatively, be capable of being opened at both ends to facilitate loading and unloading of items such as blood bags which fill the carrier. Single-ended carriers reduce the risk of entry into the system with lids incorrectly secured. However, consideration could be given to the provision of double-ended carriers incorporating two internal compartments. Subject to space limitations this would allow transporting associated paperwork with samples without it being affected by leakage or spillage. The carrier lids should be of the swivel pattern designed so that the lid is positively secured before loading the carrier into the system (an insecure lid may be dislodged by the system). An automatic detection device that stops the carrier leaving the station with an insecure lid would prevent accidents. Carriers should be fitted with 'Velcro' (or equivalent) rings to ensure good seals and should be transparent, to enable the contents to be viewed by the recipient before opening the carrier.

Station carrier arrival alarms

3.15 A station carrier arrival alarm should indicate the arrival of each carrier at the station. The alarm could be in the form of a light which should remain lit until acknowledged by a member of staff, therefore accepting delivery of the carrier. If an audible alarm is also fitted, a time out facility should be incorporated to time out the sounder (but not the light), the timer being adjustable between 0 - 15 minutes. The system manager should be able to disable the facility, for example, during the night or whilst the system is being commissioned. Carrier arrival sounders should be programmed not to sound when receiving empty carriers.

Noise

3.16 If a sounder is used at the station to indicate 'carrier arrival' and 'carrier send', it would be useful for staff to be provided with the option to disable the sounder.

Station directory and operation instructions

3.17 Each station should be provided with a laminated/encapsulated list of instructions, which should be mounted on or adjacent to the station. The label should be easy to clean, securely fixed and should include the following:

- a directory of all available stations;
- clear, step-by-step operating instructions;
- action to be taken in the event of system failure.

Station visual display screens

3.18 Each station should be equipped with a visual display unit having at least a four line, 20 characters per line minimum. Normally a liquid crystal display screen is

incorporated in the station housing. With today's developments it could be expected that the new generation of visual displays will be of the touch-screen type.

3.19 When a carrier is sent from any station, the visual display screen at the station should:

- indicate that the station is ready to accept a carrier;
- request the identification of the destination station;
- request the confirmation of the instruction;
- confirm that the carrier has arrived at the selected destination.

Text messages on the visual display screen should be clear and easy to understand

Restriction of carrier destinations

3.20 The system manager should be able to programme the central controller to prevent users from sending carriers to particular station(s) within the network, for example, if a department is vacated at night or if a station is shut down for maintenance. The system manager should also be capable of diverting carriers sent to one station to another if required by the users. Users should have the capability of forwarding carriers from the individual stations if released by the system manager.

Incorrect or unobtainable destination

3.21 The management of carriers directed to a closed/barred or non-existent station will depend upon the structure of the send station:

- bottom loaded stations: the carrier will not be accepted into the system;
- exposed carrier stations: the carrier should be removed manually; or
- covered carrier stations: the carrier will be accepted into the system but will be rejected immediately into the stations arrivals basket;
- wrong selection indication if operator selects an invalid address.

Station availability

3.22 If a station or the system is non-operational for any reason the screen should display 'system out of use' or 'station out of use', as appropriate. This is in addition to the warning light requirement stated elsewhere.

Station/system availability indication light

3.23 The station display should incorporate: - a 'station availability' light: a green light indicating that the station is open and available for use and a red light indicating the station/system is out of use due to a fault or other failure. Any fault

or other failure should show up as a system alarm on the main/master controller.

Station mounting heights

3.24 For top and front entry stations the mounting height to the top of the cabinet should be 1.6m above finished floor level.

3.25 For bottom loading stations the mounting height from the bottom of the station should be 1.2m above finished floor level.

Active carrier monitoring

3.26 The carrier's progress throughout the system should be monitored. Electronic RCI tagging for automatic return to source may be relevant in certain instances but this facility could inhibit the flexibility within the system. Monitoring should be carried out by using beam detectors or micro switches. The beam detectors should only operate in the non-visible part of the light spectrum. The detectors should not be sensitive to daylight or any form of artificial lighting as this will prevent fault detection. It should be possible to request progress reports in the following areas:

- at send station:
  - carrier loaded;
  - carrier accepted;
  - carrier despatched;
- at diverter and carrier storage locations (if installed):
  - arrival;
  - location of carrier in storage system/multi send station storage magazines/system interchange unit;
  - departure.

3.27 The above should apply to any other system component with moving parts designed to accommodate/facilitate the transport of carriers:

- at receiving station:
  - carrier approaching;
  - carrier arrived;
  - carrier exit tube clear.

System automatic purge

3.28 The system should be capable of carrying out an initial automatic purge, in an attempt to clear a blockage or sticking carrier, with the sticking carrier being purged to the source station. If the purging operation fails to deliver the carrier to the assigned destination, the carrier may be diverted to a designated station. If

the automatic purge is not successful the system will require to be reset manually. In addition to this, a Volt-free contact may be provided to allow connection to the hospital building energy management system (BEMS) to indicate an alarm condition.

Blocked exit tube at a station

3.29 The system should be capable of attempting to clear and eject automatically a blocked carrier in the exit tube at any station by agitating the station's diverter/carrier transfer mechanism.

Breakage or spillage of samples

3.30 Spillages within the tubing should be a very rare occurrence if the system is being used in a safe manner. Any high risk samples should be placed in a leak proof container (see Figure 5), which in turn is placed in a sealed plastic bag incorporating a request form that indicates high risk samples. It is preferable for all known high risk samples to be transported individually in a carrier, so that if breakages should occur within the carrier, other samples are not contaminated. The carrier should be transparent to allow operators to inspect carriers received visually and detect any spillages within the carrier. If the carrier contains a spillage then it should be dealt with according to procedures agreed by the Infection Control Officer, or other approved qualified person.

3.31 The carriers should incorporate a leak proof seal to prevent fluid escaping during transportation in the system and whilst being handled by staff. A check should be carried out to verify if carriers are be autoclavable. If so, sterilization of the interior and exterior of the carrier can be achieved by that method, failing which chemical cleaning will be required under laboratory conditions.

3.32 If leaking samples are allowed to enter the tube system or a station, the station should be isolated and the Infection Control Officer contacted to establish how much of the system must be isolated until removal of the carrier and disinfection/cleaning of the areas affected can be completed. The disinfection procedure or cleaning will depend on the nature and level of risk imposed by the contaminant; each incident will need to be assessed separately.

3.33 Disinfection or cleaning procedures should be determined locally in line with the healthcare organisation's policy.

Figure 4: Lockable carrier

Figure 5: Carriers with swivel-lids

Transaction records

3.34 The system's central processor should be equipped with sufficient memory to hold one month's transactions of carrier journeys, including records of all diverter positions, station positions etc. To provide an audit trail and to assist with fault findings, this information should be capable of being downloaded to a printer and, in addition, the records should be stored on a computer file on hard disk or other magnetic material.

3.35 Faults on the system should also be recorded electronically as a print file as they occur. A paper record may be preferred.

Fire alarm interface

3.36 The system's central control should be equipped with a fire alarm interface which, in the event of a fire, will suspend its operation and reinstate the operation of carrier movement automatically on clearance of the alarm condition. The choice of the local authority or fire officer may be to use manual intervention.

4. Validation and verification

General commissioning

4.1 The commissioning of pneumatic tube transport systems helps to ensure that users develop confidence in operating the system. The majority of problems reported from existing installations can be traced back to operator error or software issues not found during commissioning. All functions of the system must be thoroughly tested including a full software check for microprocessors and computer systems to ensure that software issues are eliminated.

4.2 The test sheet in Appendix 1 is generic and will probably need to be modified to meet the requirements of the manufacturer of the actual system. Additional sheets will be required for other items and these should be created by the designer with advice from the manufacturer.

4.3 The project file (as defined in the Construction (Design and Management) regulations) should be available before commissioning commences and should contain:

- operation and maintenance manuals for system and all installed equipment;
- full set of ‘as fitted’ drawings;
- full software listing of all programs used by system

Software provided by manufacturers should be capable of manipulation to allow free access for alterations, additions and updates.

Commissioning personnel

4.4 The objective of commissioning is to ensure that the system fully complies with the specification. As it is unlikely that all of the necessary commissioning skills will be possessed by one individual, a commissioning team is therefore usually required.

4.5 During the commissioning process a great deal of information about the plant will be generated which will form an invaluable source of reference. It is essential to ensure that the records are kept in a project file (commissioning manual) to be handed over to the client on completion of the contract together with the maintenance data and ‘as fitted’ drawings.

4.6 The commissioning process should be fully documented at the tender stage. The correct installation of all system parts will need to be witnessed and any tests required carried out as construction proceeds, in particular on items which may have to be covered before completion of the installation. Failure to establish responsibility for commissioning may delay the completion of the project or lead to unsatisfactory plant performance.

Commissioning brief

4.7 The commissioning team will require a detailed description of the proposed installation from the system designer. This should include:

- a 'user' brief comprising a description of the installation and its intended mode of operation;
- the precise design requirements of the particular system;
- equipment manufacturer's type test data, commissioning, operation and maintenance recommendations;
- drawings showing the layout of the system and positions of items of plant;
- wiring diagrams for all electrical equipment associated with the pneumatic tube transport system including control circuit details and any interlocking and safety devices such as emergency stop buttons adjacent to the item of plant.

4.8 On completion, the system should be subject to performance tests carried out by the contractor and witnessed by the client's representative in accordance with the contract requirements to prove operation of all items, control sequences and alarms.

4.9 The commissioning process may be carried out in the order in which it appears in this guidance document. The static checks and visual inspections should be followed by the dynamic tests, performance tests and finally the handover procedures.

4.10 On completion of the commissioning and when the system is shown to meet the design intent the handover documentation should be completed. In the event of performance not being acceptable, the matter should be dealt with in accordance with the contract arrangements.

Pre-commissioning checks

4.11 The pre-commissioning checks should consist of visual inspection, manual operation of equipment, static measurements and functional tests of individual components. They should be carried out prior to setting the system to work and undertaking the dynamic commissioning process.

Standard of installation

4.12 During the installation of the system the following should be witnessed:

- that the plant and installations have been provided and installed in accordance with the design specification and drawings;
- that all components function correctly;
- that the interlocks are operative and in accordance with specification;
- that the electric circuits are completed, tested and energised;

- that electric motors have been checked for correct direction of rotation;
- that the plant is physically complete, and if required insulation is applied and all pipework identified as specified;
- that the area containing the blower is clean and dust free;
- that access to all parts of the system is safe and satisfactory.

Cleanliness of installation

4.13 The area around the blower air intake must be free of dust, vegetation, waste, rubbish, builder's debris or any other possible source of contamination. Before setting the system into operation, tubing should be purged to an open end (control point) located in a plant room and cleared of any dirt, dust or debris accumulated during construction. On completion all filters are clear for operation.

Commissioning and testing prior to handover

General description

4.14 Immediately prior to handover the employer's representative will attend site together with the engineering supervising officer, the engineer's representative and the contractor, to witness the final acceptance testing of all systems. This will comprise, at least, testing of individual stations using the self send and receive function, operating longest runs and short runs either within each individual system or across the interchange / transfer systems. All information gathered from the completion of commissioning should be presented together with the 'as installed' drawings and manufacturer's operation and maintenance manuals.

4.15 Spot checks should be made and compared with information collated previously. In the event of spot checks being inconsistent with previously recorded information the element in question should be rechecked in its entirety. A check will also be made to ensure all items on the defects list have been attended to in an acceptable manner. The contractor is advised to ensure that his subcontractors are aware of the implications of the content of work contained in commissioning and testing and that all due allowance has been made within the contract programme of work. It should be noted that handover cannot proceed until testing and commissioning have been completed to the satisfaction of the engineering supervising officer.

4.16 The blower drives, direction of rotation, speed and current drawn should be set in accordance with their manufacturer's instructions.

4.17 After the installation has been checked to ensure that it is in a satisfactory and safe condition for start up, it should be set to work and regulated to enable the plant to meet its design specification.

Control system

4.18 The control system would be the first part to be commissioned after which each system would be commissioned progressively from the start / plant outward.

4.19 Because of the specialised nature of the control systems and the fact that the manufacturer's system may contain its own specialist components and settings, the commissioning should be completed by the supplier and witnessed by the employer's representative.

4.20 The location of all control and monitoring sensors should be checked and their accuracy proved.

4.21 The control system's ability to carry out its specified functions must be proved, including all alarm responses. Detectors should not be disconnected during any test.

Handover procedure

Design information

4.22 The information provided by the designer should include the following based on the NHS Board's output specification that would form the basis of a traffic flow matrix:

- schematic diagrams of pneumatic tube transport systems;
- schedules of blowers, stations, diverters, plant items, control sensors;
- schematic diagrams of the control systems marked with the set points;
- traffic flow matrix.

Acceptance checks

4.23 Before accepting the installation the client's officer, who will become directly responsible for the routine maintenance of the plant, should witness the following:

- air leakage testing would be applied to any underground runs and test certificates should be satisfactory;
- that insulation is applied and complete as specified;
- that all tubing is identified and is as specified:
- that fire protection device locations are marked;
- that all remote power supply locations are marked.

4.24 Schematic drawings showing the layout of the pneumatic tube transport system and the control scheme should be provided. A set should be suitably framed and mounted in the plant room or adjacent to the central controller if required by the hospital staff. Copies should be included in the commissioning manual.

4.25 A simple description of the system, together with instructions on the plant's mode of operation, should be provided, suitably framed in the plant room or adjacent to the plant. An additional copy should be included in the commissioning manual.

4.26 The commissioning manual should be available and should contain the information outlined in this document and detailed in the contract specification.

5. Operational Management

Management responsibilities

5.1 It is a management responsibility to ensure that inspection, service and maintenance activities are carried out safely without hazard to staff, patients or members of the public.

5.2 Clear lines of managerial responsibility should be in place so that no doubt exists as to who is responsible for the safe operation and maintenance of the equipment. A periodic review of the management systems should take place in order to ensure that the agreed standards are being maintained.

5.3 The following operational procedure will need to be defined early in the contract and before the plant may be handed over and taken into use. The procedures may be modified in the light of experience gained in the actual operation of the plant.

- safe plant start, run, set back, restart and stop procedures including minimum run up times to achieve desired operating conditions;
- condensation protection sequence, if required;
- the procedures to be adopted to protect plant integrity if it is not to be taken into immediate use.

Maintenance routines

5.4 In order that the installation can be properly maintained and operated, it is essential that users are provided with the following basic information.

- ‘as installed’ drawings;
- plant information manuals containing manufacturers’ manuals and operating instructions;
- commissioning manuals listing the results of commissioning tests as detailed in Section 4;
- any special tools and spare parts.

In addition, schedules of routine maintenance activities, suggested spares lists and operational information should be prepared.

5.5 The commissioning manual will provide full information about:

- the design intent;
- individual exhauster/blower performance, power consumption and carrier speed;

- full information as to the designed operation of the plant together with recommended maintenance procedures.

The information listed above may not be available for many existing pneumatic tube transport systems. Every effort should be made to compile it either by reference to original documents or by direct observation and measurement.

5.6 The frequency of any particular maintenance activity and the need for planned preventive maintenance can only be finally determined after monitoring the plant in operation.

Service and maintenance staff

5.7 The personnel actually charged with operating the plant should be trained in its operation and any special maintenance activities demonstrated. The training should draw attention to any potential hazards that may be encountered during maintenance.

5.8 Those required to monitor and / or maintain pneumatic tube transport systems should be competent to do so. As a minimum they will need to possess sufficient knowledge of its correct operation so as to be able to recognise faults.

5.9 Routine maintenance procedures can cause risks to the health of staff carrying out the work. Those engaged should be made aware of the risks, safe systems of work should be agreed, suitable safety equipment should be provided and training in its use should be given.

5.10 Maintenance procedures should be reviewed periodically to ensure that they remain appropriate.

5.11 Schedules of routine maintenance activities, suggested spares lists and operational information should be prepared by the manufacturer and this may need to be updated during the life of the system.

5.12 The following information should be provided adjacent to the plant to which it refers:

- general information regarding the intended operation of the plant together with a schematic diagram of the equipment and its distribution system;
- specific information as to the purpose of the plant and details of those departments and/or personnel that should be informed prior to switching off or carrying out maintenance activities;
- specific information required for the safety of the personnel carrying out the service and maintenance activities. This would include:
  - any special procedures to be followed before switching off the plant;
  - any special precautions to be taken when opening up the plant. This may be required in order to guard against radioactive, biological, chemical hazards;

- the need to isolate other plants so that they do not present hazards during the maintenance activities.

5.13 In all cases the personnel given the task of carrying out the maintenance activities must be made aware of the safe procedures to be adopted. They should be informed of the hazards to themselves and others that can occur if the agreed procedures are ignored. Reference should be made to Scottish Hospital Technical Note 4: *General purpose estates and functions model safety permit-to-work system.*

Performance monitoring

5.14 The performance of pneumatic tube transport systems should be monitored on a continuing basis. Monitoring of the conditions at the point of use will generally be carried out by users and that of the main plant and equipment by the service and maintenance staff. Agreement should be reached, between the user and those managing the maintenance of the system, as to exactly who will assume responsibility for each aspect of the performance monitoring. Those appointed should be competent to carry out their duties and be provided with the necessary facilities and training.

5.15 In monitoring the performance of the plant, the user should report any apparent fall in the standard previously being achieved to the manager responsible for the safe operation of the plant.

5.16 Service and maintenance staff should monitor the safe operation of the system and provide information as to the scale and frequency of routine maintenance. Monitoring will typically consist of a visual inspection of the items listed below.

Inspection checklist

5.17 General:

- is plant secure from unauthorised access?
- is there safe access to all parts requiring inspection?
- is the area around the plant free of rubbish?
- are all access doors and panels secure?
- internally, is the plant clean and free of visible moisture?

5.18 Air intake and discharge:

- are the units clear of rubbish?
- are louvres clean and insect/vermin screens clear?

5.19 Exhauster/blowers:

- are noise and vibration within acceptable limits?
- are drive arrangement and bearings satisfactory?

- is motor at a safe temperature?
- are all wiring connections safe?

5.20 Filters (if fitted):

- are the filters intact?
- are manometer readings between pre-set limits, if provided?

5.21 Control systems:

- are sensors in position, connected and operational?
- are control actuators connected and operational?

5.22 The above list is only intended as a guide, and should be extended or reduced to suit the particular plant.

5.23 The actual frequency of monitoring should be commensurate with the hazards arising from plant failure or faulty operation. A monthly visual inspection would be the recommended minimum; for high risk plants a weekly inspection might be more appropriate.

5.24 The keeping of excessively detailed records of inspections is not considered necessary; a simple check list with a column for comments will normally suffice.

Training

5.25 The users and those who maintain pneumatic tube transport systems will need to be instructed in their safe operation. The instruction given should draw particular attention to the following topics:

- the NHS Board's operational policy;
- the prime function of the system;
- the intended method of operating the plant or equipment;
- problems and hazards that can arise from failing to follow the agreed operating, monitoring and maintenance procedures;
- the danger of making unauthorised modifications, alterations or additions to the system as well as the possible legal consequences;
- the procedure to be followed if it is suspected that the system is no longer operating correctly.

5.26 Training in the correct operation and first line maintenance of the equipment will be provided as part of the handover procedure at the end of the commissioning period. It should be recognised that routine maintenance would require a competent engineer with specific Pneumatic Tube System skills.

5.27 The training will need to be repeated periodically thereafter in order to cater for changes in staff.

5.28 Records of the training provided should be kept.

6. Routine maintenance

General

6.1 All pneumatic tube transport systems should be subjected to an inspection, service and maintenance scheme at least every half year.

6.2 A maintenance scheme should be drawn up paying particular attention to the function of the system and the problems, arising through plant failure.

6.3 Maintenance regimes should consist of the following:

- a visual inspection to determine the condition of the plant;
- cleaning of all parts of the system as far as is practical and necessary;
- an electrical safety check of the plant;
- a functional test of all safety devices and limit controls.

An example of a check-list for the half-yearly inspection, service and maintenance of a typical pneumatic tube transport system is provided in Appendix 2.

6.4 An annual review of the operation of the plant should be undertaken. The review should address:

- the overall condition of the plant;
- the appropriateness of the specific plant operating instructions and safe systems of work;
- the management system that ensures that the standards agreed for the operation and maintenance of the plant are being maintained.

The conclusions drawn and any action taken should be recorded and the systems operating procedures amended to suit.

6.5 Substitute or replacement staff should be designated in order to cover for sickness, holidays and staff transfers.

Service and maintenance records

6.6 A service and maintenance record should be kept and should include details of the following:

- routine inspections;
- routine maintenance;
- breakdowns and unscheduled service and maintenance activities;
- refurbishment, additions and alterations;

- changes in the control strategy;
- fire protection device locations;
- disinfection of equipment;
- decontamination of the system;
- filter changes (if fitted);
- the results of any test carried out on the system.

For pneumatic tube transport systems these records can take the form of the inspection and maintenance check lists.

6.7 The records will need to be kept for at least six years and should be available for inspection as part of audit procedures.

7. Definitions

Plant system items

7.1 **Exhauster/blower:** the prime air mover providing air flow to transport carriers through the system, normally one exhauster/blower per zone. However, in a large zone additional blowers may be required to ensure the correct level of air flow in long tube runs. The exhauster/blower drive should preferably be driven by a 3-phase electrical supply.

7.2 **Station:** the user interface at which carriers are loaded or received; incorporates a key pad and visual display screen which are used to enter destination addresses and receive messages on the availability of the system/station.

7.3 **Diverter unit:** provides the facility to change direction of the carrier through the network between sending and receiving station under the control of the central control unit. Diverters may be two-way, three-way or six-way depending on the design requirements of the system. Most are now either three- or six-way.

7.4 **System interchange unit:** provides the facility to move carriers between systems. Simple interchange units would consist of Diverters or Linear Transfer units while Linear Couplers would comprise more comprehensive carrier servers.

7.5 **Point-to-point system:** comprises a single continuous pipe network.

7.6 **Multi-point system:** provides communication between all stations on a multi tube network utilising diverters to change the tube and direction of the carrier between stations.

Designated staff functions

7.7 **Management:** management is defined as the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable for the safe operation of premises.

7.8 **System manager:** a person intending to fulfil any of the staff functions specified below should be able to prove possession of sufficient skills, knowledge and experience to be able to perform the designated tasks safely.

7.9 **Maintenance person:** a member of the maintenance staff, pneumatic tube equipment manufacturer or maintenance organisation employed by the general manager to carry out maintenance duties on pneumatic tube installations.

7.10 **Infection control officer:** or consultant microbiologist, if not the same person, nominated by the management to advise on monitoring infection control policy and microbiological performance of the systems. Major policy decisions, however, should be made through an infection control committee.

7.11 **User:** the person using the system on a day-to-day basis.

7.12 **Contractor:** the person or organisation responsible for the supply of the pneumatic tube equipment, its installation, commissioning and validation.

Note: A record should be kept of those appointed to carry out the staff functions listed above. The record should clearly state the extent of the postholder's duties and responsibilities and to whom they are to report.

Any training given should be recorded together with the date of delivery and topics.

Appendix 1

Commissioning and testing checklists

A complete set of the schedules contained in this Appendix should be retained on site by the installation engineers. On completion of each test/inspection, the set should be completed, dated and signed by all parties.

The visual inspection included within these schedules should be carried out upon completion of the associated installation or where necessary in the case of hidden services at the time of installation. The purpose of the visual inspection is to ensure the installation complies fully with the specification. The BS7671: 2008 - Requirements for Electrical Installations (IEE Wiring Regulations 17th Edition, latest amendments) and all applicable British Standards and deviation from these must be noted and guidance obtained from the engineering supervising officer. In the event of failure to comply, the inspection should be repeated after the fault has been rectified. The commissioning and testing schedules have been compiled to assist as far as possible the inspection and testing on the installations; should further details or tests be deemed necessary to comply with the requirements of the specification or the IEE Regulations, it should be the responsibility of the contractor to provide these.

Appendix 1a: Pneumatic tube transport system

Commissioning sheet (sample only)

Station test & commissioning

Station area served:…… Station ID number:……..

Location:…….....

Check	Checked Acceptable	Date
Station mounted correctly		
Arrivals basket provided and satisfactorily installed		
Remote indicator light provided and wired correctly		
Remote sounder provided correctly		
Correct number of carriers provided		
Tubing installation adjacent to stations installed in a neat and workmanlike manner to specification		
Communications and DC cabling installed as specified		
Controller provided to IP32 protection standard		
Station electrical and data cabling terminated correctly		
Station cabling installed neatly and held away from moving parts		
Station mechanical components installed correctly, i.e. – no sticking carrier transfer port, motors, slides, loose screws or nuts and bolts		
Adequate circuit protection provided		
Station keys provided		
Locking mechanisms function correctly		
Directories instruction charts as specified		
Comments		

Signature of Contractor……...

Witnessed by Engineering Supervisory Officer or his Representative……

Date……

Appendix 1b: Pneumatic tube transport system

Test Record (Sample)

Station Test Sheet……..

Station Area served…… Station ID Number……..

Location……

Test	Checked Passed Yes / No	Date
Station accepts carrier smoothly and quietly		
Transfer carriage operates quietly and smoothly		
Station delivers incoming carrier quietly and smoothly		
Station sends outgoing carrier quietly and smoothly		
Station arrivals basket positioned correctly		
Station send routine operates clearly in accordance with this Specification, using plain English		
Station remote indicator lights operate when carrier arrives		
Station remote sounder (if fitted) operates when carrier arrives and can be disabled		
Electrical components operate satisfactorily		
Mechanical components operate satisfactorily		
Comments		

Signature of Contractor……...

Witnessed by Engineering Supervisory Officer or his Representative……

Date……

Appendix 2

System monitoring checklist

Blower	check air inlet is clean and clear of dust;
	vibration;
	motor temperature.
Station	Visual inspection for damage, loose fixings etc;
	check actuators;
	check drive mechanism;
	check alarm indication lights.
Diverter / zone interchange unit	Visual inspection for damage, loose fixings etc;
	check actuators;
	check air damper mechanism;
	check drive mechanism.
Filters (if fitted)	Visual inspection;
	pressure drop within limits;

References

Acts and regulations

NB: Access to information related to the following Acts and Regulations can be gained via www.legislation.gov.uk

The Building (Scotland) Act 2003, HMSO, 2003

Clean Air Act 1993, HMSO, 1993

Electricity Act 1989, HMSO, 1989

Health and Safety at Work etc Act 1974, HMSO, 1974

Registered Establishments (Scotland) Act 1998, HMSO, 1998

The Building (Scotland) Regulations 2004, SI 2004 No.406. TSO, 2004

The Building (Scotland) Regulations: Technical handbooks and guidance, TSO, 2004

Carriage of dangerous goods (classification, packaging & labelling) and Use of transportable pressure receptacles regulations 2007, SI 2007 No.1573. TSO, 2007

Chemicals (Hazard information and packaging for supply) Regulations (CHIP2) 1997, SI 1997 No.1460. HMSO, 1997

Construction (Design and Management) Regulations 2007. SI 2007 No.320, TSO, 2007.

Control of Substances Hazardous to Health Regulations (COSHH) 1999. SI 1999 No.437, HMSO, 1999.

Electricity at Work Regulations 1989. SI 1989 No.635. HMSO, 1989.

Electricity Supply Regulations (as amended) 1988 (amended 1994). SI 1994 No.1057. HMSO, 1994

Electromagnetic Compatibility Regulations (as amended 2006). SI 2006 No.3418. TSO 2006.

Gas Safety (Installation and Use) Regulations 1998. SI 1998 No.2451. HMSO, 1998.

Health & Safety (First Aid) Regulations 1981. SI 1981 No.917. HMSO, 1981.

Health & Safety Information for Employees Regulations 1989. SI 1989 No.682. HMSO, 1989.

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Pressure Systems Safety Regulations (PSSR) 2000. SI 2000 No.128. HMSO, 2000.

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Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995. SI 1995 No.3163. HMSO, 1995.

Workplace (Health, Safety and Welfare) Regulations 1992. SI 1992 No.3004. HMSO, 1992.

British Standards

BS7671: 2008. Requirements for electrical installations. IEE Wiring Regulations, Seventeenth edition. British Standards Institution, 2008.

Scottish Health Technical Guidance

Scottish Health Technical Memorandum (SHTM) 06-01: Electrical services supply and distribution. HFS, 2011.

Part A: Design considerations

Part B: Operational management

Scottish Health Facilities Note (SHFN) 30: Infection control in the built environment: Design and planning. HFS, 2007.

Scottish Health Technical Memorandum (SHTM) 2035: Mains signalling. PEFEx, 2001.

Scottish Health Planning Note (SHPN) 1: Health service building in Scotland. HMSO, 1991.

Scottish Health Planning Note (SHPN) 2: Second Hospital briefing and operational policy. HMSO 1993

Scottish Health Planning Note (SHPN) 48: Telecommunications. HMSO, 1997.

Scottish Hospital Technical Note (SHTN) 4: General purposes estates and functions model safety permit-to-work systems NHS in Scotland – PROCODE. PEFEx, 2001.

NHS Scotland Firecode and Fire Practice Notes

Scottish Health Technical Memorandum (SHTM) 81: Fire precautions in new hospitals. HFS, 2003.

Scottish Health Technical Memorandum (SHTM) 82: Alarm and detection systems. HFS, 2003.

Scottish Health Technical Memorandum (SHTM) 83: Fire safety in healthcare premises: general fire precautions. HFS, 2004.

Scottish Health Technical Memorandum (SHTM) 85: Fire precautions in existing hospitals. HFS, 2007.

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EH40 Health Technical Specification. NHS Estates, 1997.

The Scottish Infection Manual: The Scottish Office Department of Health Advisory Group on Infection: Guidance on core standards for the control of infection in hospitals, healthcare premises and at the community interface. HMSO, 1998.

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HSE Occupational exposure limits. Reviewed annually.

Categorisation of pathogens according to hazard and categories of containment. Advisory Committee on Dangerous Pathogens, (Second edition). HSE,1990.