SUP 03
Control and Management of Ventilation Systems
Unified procedures for use within NHS Scotland
Contents

<table>
<thead>
<tr>
<th>Acknowledgements</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td>1. Management roles and responsibilities</td>
<td>5</td>
</tr>
<tr>
<td>1.1 Designated staff functions</td>
<td>5</td>
</tr>
<tr>
<td>1.11 Records</td>
<td>6</td>
</tr>
<tr>
<td>1.15 Specific health and safety aspects</td>
<td>7</td>
</tr>
<tr>
<td>2. Operational procedures</td>
<td>8</td>
</tr>
<tr>
<td>2.1 Planned work or emergency work on ventilation plant</td>
<td>8</td>
</tr>
<tr>
<td>3. Ventilation Systems</td>
<td>9</td>
</tr>
<tr>
<td>3.1 General requirements - AHUs</td>
<td>9</td>
</tr>
<tr>
<td>4. Staff Training</td>
<td>16</td>
</tr>
<tr>
<td>4.4 Typical types of Mechanical Ventilation systems</td>
<td>16</td>
</tr>
<tr>
<td>5. Plant performance and records</td>
<td>18</td>
</tr>
<tr>
<td>6.1 Statutory Requirements</td>
<td>19</td>
</tr>
</tbody>
</table>

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Acknowledgements

Much of the material from which these procedures have been derived has been made available by NHS Lothian. Health Facilities Scotland gratefully acknowledges this and has taken the opportunity to make it generic rather than Health Board-specific, while also updating the content.

**Note:** This unified procedures guidance has been produced for NHS Boards to adopt or adapt to suit individual circumstances.
Introduction

Objectives of these procedures

This guidance is intended to be complementary to Scottish Technical Memorandum (SHTM) 03-01 and attempts to gather together all relevant information required to operate and maintain in a unified manner the various types of mechanical ventilation systems throughout NHS Boards' estates departments within NHS Scotland.

There are three principal objectives:

- to define activities associated with ventilation systems;
- to define the roles and responsibilities of operatives responsible for working on ventilation systems;
- to control hazards associated with work on ventilation systems.
1. Management roles and responsibilities

**Note:** It is essential that clear lines of managerial responsibility are in place for the avoidance of any doubt as to who is responsible for the safe operation and maintenance of ventilation plant and equipment. A periodic review of management systems should take place in order to ensure that agreed standards are being satisfactorily maintained. Those required to inspect, verify or maintain ventilation equipment will require to demonstrate their competence to do so. As a minimum they should have sufficient knowledge of its correct operation and be able to recognise and diagnose faults.

### Designated staff functions

1.1 Any persons intending to fulfil any of the staff functions specified below should be able to prove that they possess sufficient skills, knowledge and experience to perform safely the designated tasks.

#### Management - General

1.2 Management is defined as the owner, occupier, employer, general manager, chief executive officer or other person within or on behalf of the NHS Board ultimately accountable for the safe operation of premises.

#### Designated Person *(where applicable)*

1.3 This person is responsible for providing the essential senior management link between the NHS Board’s organisation and its professional support. The Designated Person will also be able to provide an informed position at Board level.

#### Authorising Engineer (Ventilation) [AE(V)]

1.4 The AE(V) is defined as the person appointed by Management to provide independent auditing and advice on ventilation systems, to oversee the appointment and training of Authorised Persons (Ventilation) and review and witness documentation on validation of systems.

#### Authorised Person (Ventilation) [AP(V)]

1.5 The AP(V) will be a person possessing adequate technical knowledge of ventilation systems, plant and equipment who has received appropriate training, having been appointed in writing by the Designated Person on the recommendation of the AE(V). The AP(V) will be responsible for the practical implementation and operation of the NHS Board’s management’s safety policy and procedures relating to the engineering aspects of ventilation systems.
Competent Person (Ventilation) [CP(V)]

1.6 The CP(V) will be the person defined as a person designated by the NHS Board’s management to carry out maintenance, validation and periodic testing of ventilation systems.

Infection Prevention and Control Officer

1.7 The Infection Prevention and Control Officer (or consultant microbiologist, if not the same person) will be the person nominated by the NHS Board’s management to advise on monitoring the infection prevention and control policy and microbiological performance of the ventilation systems.

**Note:** Major policy decisions should be made through an infection prevention and control committee. This committee should include representatives for the user department, estates and facilities or their nominated representative (the Authorised Person).

Plant Operator

1.8 The plant operator is any person who operates a ventilation system.

User

1.9 The User will be the person responsible for the management of the department or unit in which the ventilation system is installed. This could typically be the head of department, operating theatre manager, head of laboratory, production pharmacist, and head of research or other responsible person).

Contractor

1.10 The Contractor will be the person or organisation responsible for the supply of the ventilation equipment, its installation, commissioning or validation. This person may be a representative or a specialist ventilation organisation of a member of the NHS Board’s general manager or chief executive officer’s staff. When a hospital facility has been procured via PPP/PFI funding, the operation and periodic validation of ventilation systems will be undertaken through the funding consortia’s facilities management provider, albeit responsible directly to the NHS Board.

Records

1.11 A record should be retained of those appointed to carry out the above functions, clearly stating the extent of the post-holder’s duties and responsibilities and to whom they are to report.

**Note:** Substitute or replacement staff should be designated in order to cover for sickness, holidays and staff transfers.
1.12 Routine inspection and maintenance procedures can cause risks to the health of staff undertaking the work and those receiving air from the plant. All those involved should be made aware of the risks and safe systems of work should be agreed. Suitable safety equipment should be provided as necessary and training should be given on its use.

1.13 Any training provided should be recorded together with the dates of delivery and the topics covered.

1.14 Training in the use of safety equipment and safe systems of work will need to be repeated from time to time to cater for changes in staff.

### Specific health and safety aspects

**Note:** Staff engaged in the service and maintenance of extract ventilation systems may be particularly at risk from the likes of pathology departments, mortuaries, laboratories, source-protective isolation facilities and other areas containing a chemical, biological or radiation hazard. In such cases the risk should be identified and assessed.

1.15 The means by which a system can be rendered safe to work on should be determined and a permit-to-work on the system implemented.

1.16 Training in the exact procedures should be provided for all staff involved.

1.17 Some healthcare facilities such as pharmacy aseptic suites may contain specialised units that are subject to access restrictions. Estates or contract staff requiring access may need additional training or have to be accompanied when entering the unit.

**Note:** Reference should be made to the following guidance published by the Health & Safety Commission’s Health Service Advisory Committee:

1. ‘Safe working and prevention of infection in clinical laboratories and similar facilities’;

2. ‘The management, design and operation of microbiological containment laboratories’;

3. ‘Safe working and prevention of infection in the mortuary and post-mortem room’.
2. Operational procedures

**Note:** The procedure for working on, operating or purchasing ventilation plant will vary depending on its use.

**Planned work or emergency work on ventilation plant**

2.1 Do’s and don'ts

- No ventilation system should be switched off without first considering what the plant is supplying and the consequences. This should be checked with the user;
- If the plant operating parameters are to be changed, check with the AP(V);
- When working on local exhaust ventilation (LEV) systems, always check with the user before commencing work. Decontamination of a cabinet may be required before starting work. A Permit-to-Work may be needed;
- Supply and extract systems may be electrically interlocked. The plant information records should be checked.

**Log Sheets**

2.2 Log sheets should be located adjacent to each large ventilation system and completed and filed in the plant performance folder on completion of any work carried out. The following information should be provided adjacent to the plant:

- schematic diagram and department served;
- safety information for department and maintenance personnel;
- filter information;
- plant operating pressure.

**Note:** Plant performance sheets should be completed and filed in a plant performance folder in the NHS Board’s Estates Office.
3. Ventilation Systems

General requirements - AHUs

3.1 All ventilation plant should have been designed and installed to ensure that the ‘Environmental Protection Act 1990, Part III: Statutory Nuisance’ and the ‘Noise and Statutory Nuisance Act 1993 have not been contravened.

- all ventilation systems should be inspected annually to ensure conformity with minimum requirements which are designed to;
  - ensure safe access when carrying out routine service and maintenance tasks;
  - prevent or control risks associated with *Legionella* and other potential hazardous organisms;
  - check that the system remains fit for purpose;
  - maintain records of outcome.

3.2 Every effort should be made to ensure that all air handling units (AHUs) achieve the minimum requirements set out below.

**AHU Location and access**

3.3 All AHUs should be secured from unauthorised access.

3.4 Units located on roofs must have a safe and permanent means of access. Suitable precautions must be in place to prevent personnel, equipment or tools from falling during maintenance activities.

3.5 Units located outside at ground level should be secured within a lockable compound to prevent unauthorised access. Vehicles should be excluded from the vicinity to ensure that exhaust fumes are not drawn in to intakes.

3.6 All parts of AHUs should be easily and safely accessible for routine inspection and service.

3.7 The area around an AHU within a building should be tanked to prevent water penetration to adjacent areas, and should be adequately drained.

3.8 Fire precautions should be in accordance with Firecode (SHTMs 81-86)

3.9 Combustion equipment must not be located in a fire compartment that houses air handling equipment.

3.10 Plantrooms that house AHUs must NOT be used for general storage. Care should be taken to ensure that combustible material is not kept in the plantroom.
3.11 The plant must not contain any material or substance that could support the growth of microorganisms.

3.12 The plant must not contain any material or substance that could cause or support combustion.

3.13 Access to items that require routine service such as filters, coils and chiller batteries, should be via hinged doors. Where ventilation plant is located externally stays should be incorporated to hold doors in the open position requiring manual intervention to close the door.

3.14 Items requiring infrequent access such as attenuators may be via clipped or bolted-on lift-off panels. To prevent injury due to the mass of bolted-on or lift-off panels, the design of the AHU equipment should ensure that access to these items is from either the side or top, never from underneath. This is especially important where AHUs are located within ceiling spaces.

3.15 All doors and panels should be close-fitting and without leaks.

3.16 Every effort should be made to ensure that access can be achieved via fixed ladders and platforms or by pulpit-style movable steps.

3.17 Electrical and mechanical services should not restrict or impede access to those parts of the AHUs that require inspection.

3.18 Viewing ports and internal illumination should be installed in order to inspect filters and drainage trays.

3.19 Internal illumination should be provided by fittings to at least IP55 rating and should be positioned so that they provide both illumination for inspection and task lighting.

3.20 All the lights within a unit should be operated by a single switch.

**AHU intakes and discharges**

3.21 Air intake and discharge points should not be located where they will cause vitiated air to be drawn into a system. In existing systems it may be necessary to extend the intake or discharge point to a suitable position. (SHTM 03-01 Part A; paragraphs 3.61-3.71 also refer).

3.22 Each air intake and discharge point should be fitted with corrosion-resistant weatherproof louvers or cowls to protect the system from driving rain. The inside of the louvers should be fitted with a mesh of not less than 6mm and not more than 12mm to prevent infestation by vermin and prevent leaves being drawn in.

3.23 The duct behind a louvre should be self-draining. If this is not practicable it should be tanked and provided with a drainage system. Cleaning access must be provided either from the outside via hinged louvers or by access doors within the plenum on the inside. Where a common plenum is provided for more than one system, cleaning access should be via a walk-in door.
3.24 Where intakes are fitted with a frost battery these should be of the “open coil” pattern not requiring pre-filters. Removable filters must be fitted before incoming air passes through heater batteries.

**AHU drainage system**

3.25 All items of plant that could produce moisture must be provided with a drainage system. The system will consist of a drip-tray, glass trap, air break and associated drainage pipework.

3.26 Some existing AHUs may not have been mounted far enough above the finished floor level to permit the correct installation of a drainage system. If an AHU cannot be raised to an adequate height an alternative arrangement (such as a pump-out system) must be provided. Where pump-out systems are incorporated they should be fitted with equipment fail indicators.

3.27 The drip-tray should be constructed from a corrosion-resistant material such as stainless steel and arranged so that it will drain completely. To prevent ‘pooling’ it is essential that the drain connection should not have an upstand and that a slop of approximately 1 in 20 in all directions should be provided to the drain outlet position. The tray must be completely accessible or, for smaller units, easily removable for inspection and cleaning.

3.28 Each drip-tray should be provided with its own drain trap of the clear (borosilicate) glass type to allow the colour of the water to be observed, giving an early indication of corrosion, biological activity or contamination within the duct. (Reference should be made to SHTM 03-01 Part A, paragraphs 4.20-4.25 and Part B, paragraph 3.29 for further information).

3.29 The trap should incorporate a means of filling and should have couplings to facilitate removal for cleaning. It should be located in an easily visible position where it will not be vulnerable to casual knocks. Pipework connecting it to the drainage tray should have a continuous fall of not less than 1 in 20.

3.30 Traps fitted to plant located outside or in unheated plantrooms may need to be trace-heated in winter. The trace-heating should be checked for operation and must not raise the temperature of the water contained above 5°C.

3.31 Water from each trap must discharge via a clear air gap of at least 15mm above the unrestricted spill-over level of either an open tundish connected to a drainage stack via a second trap, or a floor gully (or channel). A support should be provided to ensure that the air gap cannot be reduced. More than one drain trap may discharge into a tundish provided each has its own air break.

3.32 Drainage pipework may be thermoplastic, copper or stainless steel. Glass should not be used except where previously described. Pipework should be of minimum diameter 22mm and have a fall of at least 1 in 60 in the direction of flow. Pipework should be well supported and located so as not to inhibit access to the AHU.
**Dampers**

3.33 AHUs serving critical areas and those that are shut down out of hours should be fitted with motorized low-leak shut-off dampers located immediately behind the intake and discharge of each supply and extract system.

**Fan drives**

3.34 Fan-drive trains, both supply and extract, should be easily visible without the need to remove access covers. Protecting the drive train with a mesh guard is the preferred option. For weatherproof units in outside locations the fan drive should be enclosed but easily visible through a viewing port with internal illumination and accessible via a lockable hinged door.

3.35 The motor windings of induction-drive “plug” motor arrangements and in-line axial flow fans having a pod motor within the air stream must be protected from over-temperature by a thermistor and lockout relay.

**Note:** Where a fan is operated through a computer control system, it is necessary to ensure that it can be switched to a direct start with fixed speed and manual operation should the software develop a fault. This is particularly important for critical care systems serving operating theatre suites, high dependency care units of any type, isolation facilities, laboratories and pharmaceutical production suites.

**Heater and frost batteries**

3.36 Access for cleaning must be provided on both sides of heater and frost batteries.

3.37 Where auxiliary or ‘trimmer’ wet heater batteries are located in false ceiling spaces they should be fitted with a catch tray and leak detection alarm. The catch tray should be installed under both the battery and the control valve assembly to protect the ceiling from leaks. A moisture sensor should be fitted in the tray. However, placing wet heater batteries in ceiling voids should be a last resort and avoided if at all possible.

3.38 Frost batteries should be of the ‘open coil’ (i.e. no fins) type as described in SHTM 03-01.

**Cooling coils**

3.39 Each cooling coil (whether forming part of an AHU or within a branch duct) must be fitted with its own independent drainage system as previously described. A baffle or similar device must be provided in the drip-tray to prevent air bypassing the coil and the tray should be of sufficient size to capture the moisture from the eliminator, bends and headers.

3.40 The cooling coil control valve should close upon selection of low speed, system shutdown, low air-flow or fan failure.
Where auxiliary wet cooling coils are located in false ceiling spaces they should be fitted with a catch tray and leak detection alarm. The catch tray should be installed under both the battery and the control valve assembly to protect the ceiling from leaks. A moisture sensor should be fitted in the tray.

### Humidifiers

3.42 Humidifiers are no longer routinely required. Where they are fitted but have been out of use for a significant period of time they should be removed. All associated pipework should also be removed back to its junction with the running main.

3.43 Where humidifiers are fitted and their use is still required or can be justified they should fully conform to the installation standards as set out in SHTM 03-01 Part A, Section 4.

**Note:** The section of ductwork containing the humidifier may require to be periodically decontaminated for which hinged access doors with viewing ports and internal illumination should be provided.

3.44 All humidifiers must be fitted with their own independent drainage system as previously described.

3.45 Only steam-injection humidifiers, whether mains fed or locally generated, are suitable for use in air conditioning systems within healthcare facilities. Water humidifiers (such as spinning disc type) if still fitted, should be removed.

3.46 Self- and locally-generated steam humidifiers must be supplied with potable water and the installation should be capable of being isolated, drained and cleaned. SHTM 03-01 Part A, Section 4 also refers.

3.47 Some steam generators are of a type that requires regular cleaning and descaling. The installation should enable them to be physically isolated from the air duct in order to prevent contamination of the air by cleaning agents.

3.48 The humidifier control system should fully conform to the standard set out in SHTM 03-01 Part A, Sections 4 and 6.

### Filtration

**Note:** Filters must be securely housed and sealed in well-fitting frames that minimise air bypass as this significantly reduces filter efficiency; the higher the filter grade, the greater the effect. Mounting frames should be designed to ensure that the air-flow pushes the filter into its housing to help minimise air bypass.

3.49 All filters should be of the dry type. Panel filters are generally used as pre-filters and should be positioned on the inlet side of the supply fan, downstream of the frost coil. Where required, secondary filters (usually of the bag-type or pleated paper) should be on the positive-pressure side of the fan.
3.50 The filter installation should provide easy access to filter media for cleaning, removal or replacement. A hinged access door should be provided for this. The upstream side of the filter should be visible for inspection by means of a viewing port with internal illumination.

3.51 All filters should be complete with a means of checking the differential pressure across them. Direct-reading dial-type gauges marked with clean and dirty sectors are preferred. During commissioning of ventilation plant the “design dirty pressure” value should be clearly marked on the respective gauges for future reference.

**High-efficiency filters – HEPA and ULPA**

3.52 Where fitted, HEPA filters should be of the replaceable-panel type with leak-proof seals. Their installation should permit the validation of the filter and its housing.

3.53 HEPA filters are sometimes used in extract systems for the containment of hazardous substances or organisms. They may be fitted with pre-filters to extend their service life.

3.54 When used in this way the installation should incorporate designed provision for the subsequent safe removal and handling of contaminated filters by maintenance staff.

**Energy recovery and Control**

3.55 Energy recovery, where fitted, will require cleaning access to both sides of the device.

3.56 Whichever type of energy recovery device is installed the extract side should be protected by a G3 filter and provided with a drainage system to remove condensate.

3.57 The heat recovery device should be controlled in sequence before utilisation of the main heater battery and may need to incorporate a control to prevent the transfer of unwanted heat when the air-on condition rises above the plant’s required set point.

**Note:** To ensure continuing energy conservation the control system utilized in providing AHU time and temperature control will be regularly tested to ensure that all components are operational, are in calibration and that the system is performing correctly without any instability in control loops detected. Where faults are detected either in hardware, software or control loop stability these will require to be corrected as soon as possible.

**Attenuation**

3.58 Cleaning access should be provided at both ends of any attenuator unit.


Identification and labelling

3.59 All supply and extract ventilation systems should be clearly labelled. Labels should identify both the AHU and the area that it serves. The lettering should be at least 50mm high and be mounted in an easily visible place near the fan of the unit. Any sub-systems and the principal branch ducts should be similarly labelled.

3.60 The direction of air-flow should be clearly marked on all main and branch ducts.

3.61 All air-flow test points should be clearly identified and the size of the duct given. All air-flow test points should be fitted with tight fitting removable rubber (flanged) grommets to prevent air loss / ingress.

Pressure stabilisers

3.62 Pressure stabilisers should be unobstructed and silent in operation.
4. Staff Training

4.1 Training will be appropriate to the staff member and reflect his/her involvement in ventilation management and maintenance.

4.2 Training can be provided by manufacturers, installers, external approved training bodies and in-house estates staff.

4.3 The following topics will typically be covered:

- Electrical Safety
  - all staff to be authorised, competent or skilled under the NHS Board’s Electrical Safety Policy.

- Personal Protection
  - staff to be aware of and possess a copy of the NHS Board’s Personal Protection Policy. Any specialised protection will be provided and recorded separately.

- Ventilation Measurements
  - training in the use of the instrumentation, interpretation of the readings and the effect on plant due to changes in parameters.

- Control of Legionella
  - awareness of the implications of *Legionella* and the possible causes in a ventilation system. The method of reporting a potential hazard and the appropriate treatment.

- Working on Steam Systems
  - awareness of the guidance given in the NHS Board’s Steam Generating Plant Policy. (SHTM 08-08: Pressure Systems, also refers.).

Typical types of Mechanical Ventilation systems

4.4 Depending on the complexity, size and extent of facilities, the following would be expected:

- wall fans (supply or extract);
- roof fans (supply or extract);
- air handling and distribution plant;
- general extract plant;
- dirty extract;
- local split system air cooling systems;
- laminar flow installations;
• air conditioning systems;
• supply and extract with heat recovery;
• supply and extract with percentage fresh air;
• local exhaust ventilation systems.

**Local exhaust ventilation systems**

4.5 Local exhaust ventilation (LEV) systems are used to protect personnel from chemical, gaseous, biological and general dust hazards. They are designed to capture the pollutant at source and safely discharge it. The following are typical examples of LEV applications:

- laboratory fume cupboards;
- pharmacy safety cabinets including cytotoxic cabinets;
- pathology microbiological safety cabinets, formaldehyde mixing and specimen preparation bays;
- gluteraldehyde mobile cabinets and workstations;
- dental grinders, buffers, casting machines, sand blasters and plating baths;
- X-ray and photographic film processing units;
- mortuary bone saws, dissection table and specimen bench extracts;
- fixed and mobile welding and soldering bay fume extract equipment;
- battery charging bay extracts;
- wood working machinery dust control systems;
- general dust extract systems.

**Note:** HSE Document ‘Controlling airborne contaminants at work’ (appendix 1 refers) offers sound advice on all aspects of LEV systems and is available as a free download from their website.

All LEV systems must be subjected to an initial thorough examination and test. HS(G)54 ‘The Maintenance Examination and Testing of Local Exhaust’.
5. **Plant performance and records**

5.1 All plant information will be filed in the estates office in plant and performance records.

5.2 Any alteration to plant, measurements taken or testing must be recorded on the correct documentation.

5.3 The following information should be retained:

- Original Commissioning Information;
- Plant Data Sheet;
- Plant Performance Sheet;
- Ventilation Grille Layout;
- Log-Sheet (Ventilation plant);
- Amendment Sheet;
- Fire Damper Tests;
- Microbiological Performance Tests;
- Plant Disinfection Records;
- Cleaning Programme;
- Ventilation Register;
- Log Sheet (LEV);
- Permit-to-Work (LEV).
6. Statutory Legislation and Guidance

Statutory Requirements

6.1 It is the responsibilities of the owners, operators and occupiers of premises, general managers and chief executives to ensure that their premises and the activities carried out within the premises comply with all statutes.

6.2 The following comprise the most important statutory requirements affecting ventilation systems:

- Health and Safety at Work etc. Act 1974;
- Management of Health and Safety at Work Regulations 1992;
- Workplace (Health, Safety and Welfare) Regulations 1992;
- Provision and Use of Work Equipment Regulations 1998;
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1985;
- Control of Substances Hazardous to Health (COSHH) Regulations 2002;
- Manual Handling Operation Regulations 1992;
- Personal Protective Equipment at Work Regulations 1992;
- Electromagnetic Compatibility Regulations 1992;
- Control of Legionellosis;
- HVCA Cleanliness of Ventilation Systems PR/17;
- HSE Controlling airborne contaminants at work.