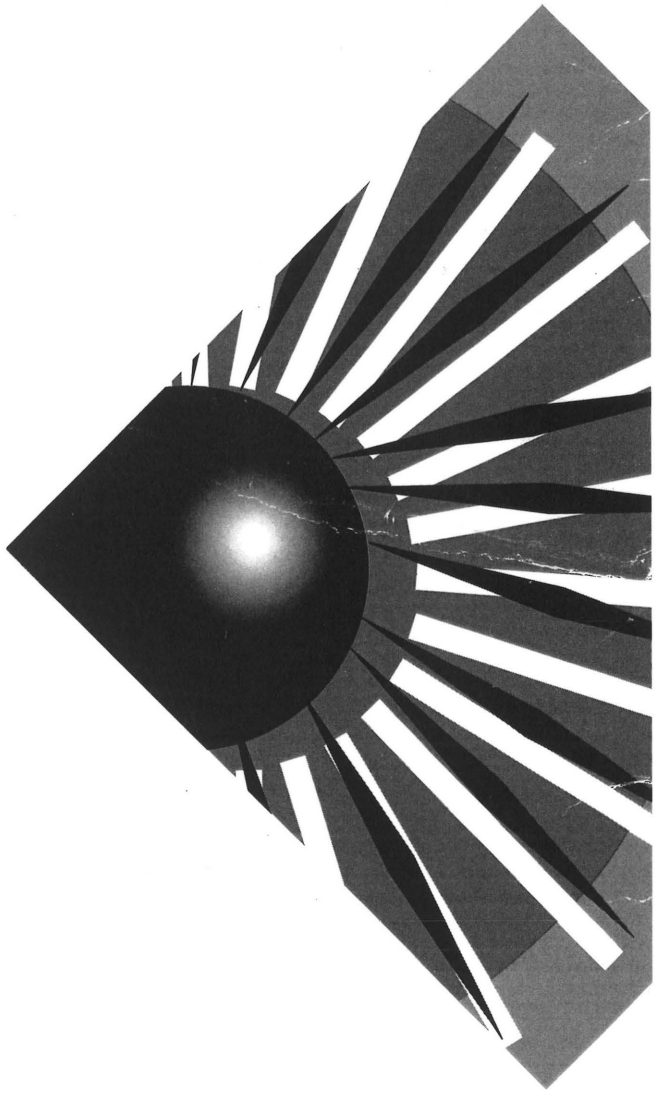
Facilities Management Specification

1

GUIDANCE AND THE STANDARD SPECIFICATION FOR VENTILATION HYGIENE



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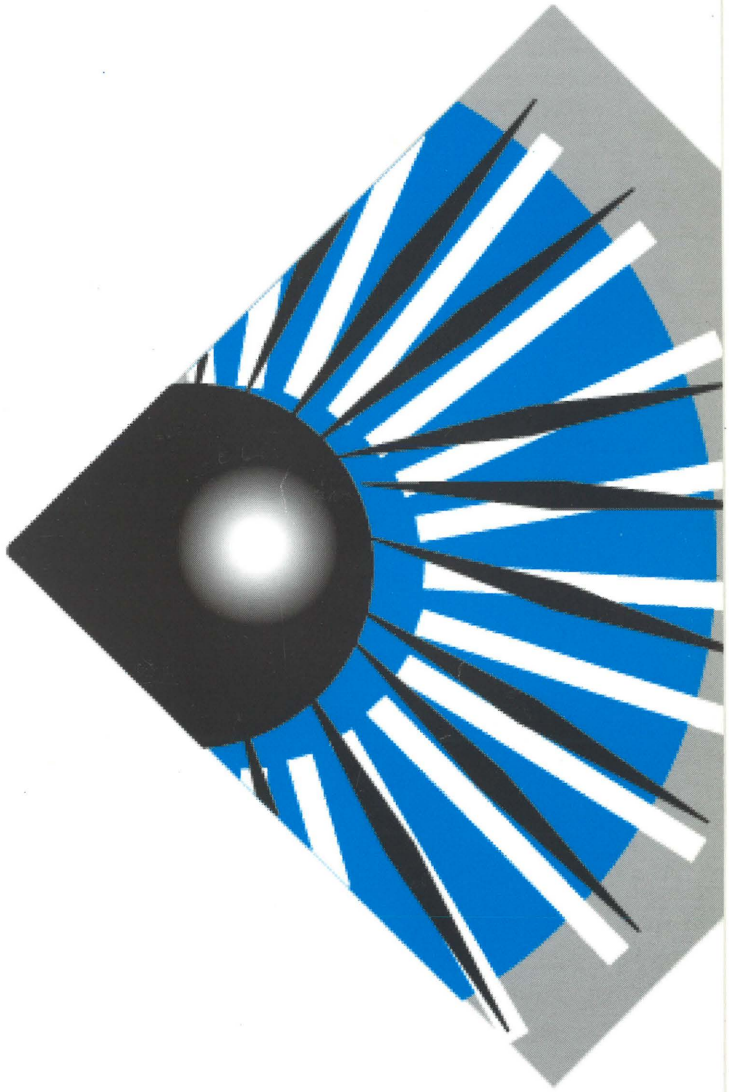
STANDARD SPECIFICATION FOR VENTILATION HYGIENE

S.R. Loyd



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STANDARD SPECIFICATION FOR VENTILATION HYGIENE

S.R. Loyd

The Building Services Research and Information Association
Old Bracknell Lane West
Bracknell, Berkshire RG12 7AH UK
Tel: +44 (0) 1344 426511 Fax: +44 (0) 1344 487575

BSRIA

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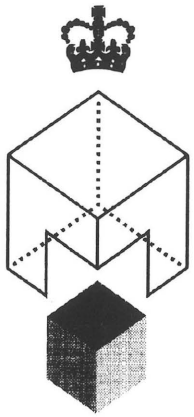

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Acknowledgement is also given to Mr T Mulhall of the Health and Safety Executive and Mr S Wray of Filtration Engineering.

Every opportunity has been taken to incorporate the views of the editorial panel, but final editorial control of this document rests with BSRIA.

CONTENTS

1 SCOPE

This part of the Specification provides the basis for a ventilation hygiene contract between a Client and a Contractor.

1.1 The Specification refers to the combination of all components required to provide ventilation or air conditioning in buildings.

1.2 'Client' refers to the person(s) having control over the premises.

1.3 'Contractor' refers to anyone contracted to provide services.

1.4 Clauses within this Specification take the form of what 'should' be done. These represent current practice at the time of writing. Whilst these requirements are not mandatory, the Contractor shall list in the Tender where they are to be excluded or modified for the project.

1.5 For any questions of interpretation of these clauses the definitions provided in *"Guidance to the Specification for Ventilation Hygiene"* [Ref 1] should be used.

1.6 The Specification must be read in conjunction with, and may be modified by, other documents comprising the full project Specification.

1.7 The Contractor shall seek clarification from the Client where Specification clauses are retained but do not correspond to the requirements for the project.

1.8 Unless otherwise specified the work shall comprise all labour and all materials necessary to complete the works, and such tests, adjustments, and making good defects as are presented in subsequent clauses.

1.9 All work and procedures must adhere to all relevant regulations, statutes and recognised codes of practice.

1.10 All work and procedures will take due care of internal contents and fabric of the building.

2 MANAGEMENT OF VENTILATION HYGIENE

2.1 The Contractor shall provide to the Client information as required to allow the Client to assess the competency of the Contractor.

2.2 The Contractor's insurance arrangements must comply with the tender requirement and be in force before work is allowed to commence. The Contractor should make available copies of the policies for approval.

2.3 The Contractor shall utilise existing access doors where possible.

2.4 Where additional access doors are required the Contractor shall ensure they comply with HVCA Specifications [Ref 2].

2.5 The Contractor should mark on existing drawings the positions of any new access doors to be installed.

2.6 The Contractor shall make good any incidental damage caused during the cleaning process.

2.7 The Contractor shall clean up after completion and leave the premises in an as found condition. This includes the necessary bagging and labelling of waste materials to comply with COSHH and the Environment Protection Act Duty of Care.

The Client shall demonstrate management control over the condition of the ventilation system (Refer to Section 2.1) in "*Guidance to the Specification for Ventilation Hygiene*").

The Client should decide whether to commission a Building Services Consultant to advise on ventilation hygiene matters or whether to deal with them in-house.

The Client shall define the objectives of the cleaning. Once the objectives have been defined, the Client should write a brief to define the actual scope of works which will include a schedule of systems to be cleaned.

The Client shall make available records of existing plant and hazardous materials and update these records as and when alterations are carried out.

The Client should confirm details of a Contractor's insurance cover.

The Client should assess the competency of any Contractor tendering to undertake a ventilation hygiene contract.

3 INSPECTION, SAMPLING AND TESTING

3.1 Before the contract the Contractor shall agree with the Client a protocol for inspection, sampling and testing as appropriate to the type of building or system.

3.2 All microbiological tests and laboratory analysis shall be carried out under a recognised quality assured laboratory and system.

3.3 The Contractor shall submit a report to the Client detailing the results of any inspection and sampling.

4 LEVEL OF CLEANLINESS

4.1 The Contractor shall agree with the Client or the person responsible for checking work and agreeing completion, the method that will verify whether the agreed level of cleanliness has been achieved.

4.2 If microbiological surface sampling is employed, the Contractor shall state which laboratory will be used and the testing protocol employed.

The Client shall define the level of cleanliness and any requirement for disinfection prior to issuing of tenders.

5 CLEANING METHODS

5.1 Prior to commencing work the Contractor shall provide a method statement to justify the use of the cleaning method he proposes to achieve the agreed level of cleanliness.

5.2 The Contractor shall justify in writing any variations to the agreed method statement.

5.3 The Contractor shall carry out the works in a manner that prevents the recontamination of previously cleaned parts of the system during the remainder of the cleaning process.

5.4 The Contractor shall remove or protect any HVAC sensors prior to cleaning.

5.5 The Contractor shall leave any fire damper in a fully open position.

5.6 Where vacuum extraction equipment is to be used that exhausts air inside the building, the Contractor shall ensure the equipment is fitted with F7 grade filters as a minimum.

6 HIGH RISK EXTRACTION SYSTEMS

6.1 Where cleaning is required the Contractor shall provide a method statement to justify the use of the cleaning method he proposes to achieve the agreed level of cleanliness. The method statement should make due consideration for particular hazards associated with the deposits in the system.

6.2 The Contractor shall justify in writing any variations to the agreed method statement.

7 DISINFECTION

7.1 The Contractor shall present to the Client a written rationale for disinfecting any ventilation system.

7.2 Where disinfection of ventilation systems is undertaken the Contractor shall ensure the following:

- that the operatives performing it are competent
- that the disinfectant to be used is known and appropriate
- that manufacturer's instructions are strictly followed
- that all necessary information required by COSHH is available
- that the method is specified and agreed with the Client
- that occupants will be informed and protected
- that the facility will be protected against deleterious effects of the disinfectant.
- that quality control by some means of verifying efficacy of disinfection is provided. This is usually by microbial testing of treated surfaces to confirm a significant reduction in the number of microorganisms present
- that residual quantities of disinfectant present in the system after cleaning do not present a nuisance or hazard to the occupants or system.

The Client should balance against any benefits obtained by disinfection any potential hazards to building occupants from the materials introduced.

The Client should be certain that disinfection will provide a benefit that cannot be gained by other less invasive methods such as frequent cleaning, humidity adjustment or replacing vulnerable surfaces with more resistant materials.

8 ELIMINATION OF ODOURS

8.1 The Contractor shall seek to identify the source of the odour by undertaking a detailed visual and nasal inspection of the system using access openings as inspection points.

8.2 The Contractor shall physically remove the source of the odour as far as practical, using cleaning techniques appropriate to the odour source identified, and disinfection where applicable.

9 CLEANING AFTER FIRE AND SMOKE DAMAGE

9.1 The Contractor shall inspect for damage due to heat and smoke.

9.2 The Contractor shall report the extent of any damage.

9.3 The Contractor shall undertake remedial action as detailed in the scope of works.

The Client shall agree the scope of works with the insurance company loss adjuster prior to giving instructions for the Contractor to proceed with remedial work.

12 FAULT REPORTING

12.1 The Contractor shall produce a detailed report on all faults found in a format agreed with the Client.

12.2 The Contractor shall designate a project manager.

12.3 If minor remedial works (eg replacing or refitting flexible connections, replacement of worn door seals) are to be included in the contract, the Contractor should identify what remedial work has been carried out and the location.

The Client should provide a contact name and telephone number for the out of hours reporting of urgent faults.

13 POST-CLEANING REPORT

13.1 After the system has been cleaned the Contractor shall prepare a report for the Client.

13.2 The Contractor shall issue a certificate of cleaning.

13.3 The Contractor shall present satisfaction/acceptance notes to the Client throughout the contract at stages identified in the contract documents or work schedules.

The Client should give system drawings to the Contractor for him to mark the location of all new access doors. If drawings are not available the Contractor should identify, in an agreed format, where new doors have been installed.

The Client shall decide on the remedial action for major or serious faults. If the Contractor is required to carry out repairs in addition to the main contract then this shall be supported by a variation order raised by the Client. No such remedial work is to be started without explicit Client approval.

14 SYSTEM BALANCE AND REBALANCING AFTER CLEANING

14.1 The Contractor's prime responsibility is to clean the ventilation system. During cleaning it may be necessary to alter the position of volume control dampers. The Contractor shall mark the as-found position of the volume control dampers and return them to that setting after cleaning.

The Client shall run the system after cleaning to check plant operation and system function.

The Client should form a separate contract with the Contractor if system re-balance is required to balance the volume airflow.

REFERENCES

1 LOYD S. *Guidance to the Specification for Ventilation Hygiene.* FMS 1/97. BSRIA 1997. ISBN 0 86022 454 6

2. HEATING AND VENTILATING CONTRACTORS ASSOCIATION. *Specification for Sheet Metal Ductwork. Low and High Velocity/Pressure Air Systems.* DW141. HVCA 1977

3. DEPARTMENT OF THE ENVIRONMENT. *Environmental Protection Act 1990 (S34) Waste Management: The Duty of Care.* HMSO 1991. ISBN 011 752557.

4. *Special Waste Regulations 1996.* SI972. HMSO 1996. ISBN 011 0545656.

5. *Waste Management Licensing Regulations 1994.* SI1056. HMSO. 1994. ISBN 011 0440560.

6. *Water Resources Act 1991.* HMSO. 1991. ISBN 010 5457914

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For further details contact Marketing Services at BSRIA.

The Building Services Research and Information Association
Old Bracknell Lane West, Bracknell, Berkshire RG12 7AH UK
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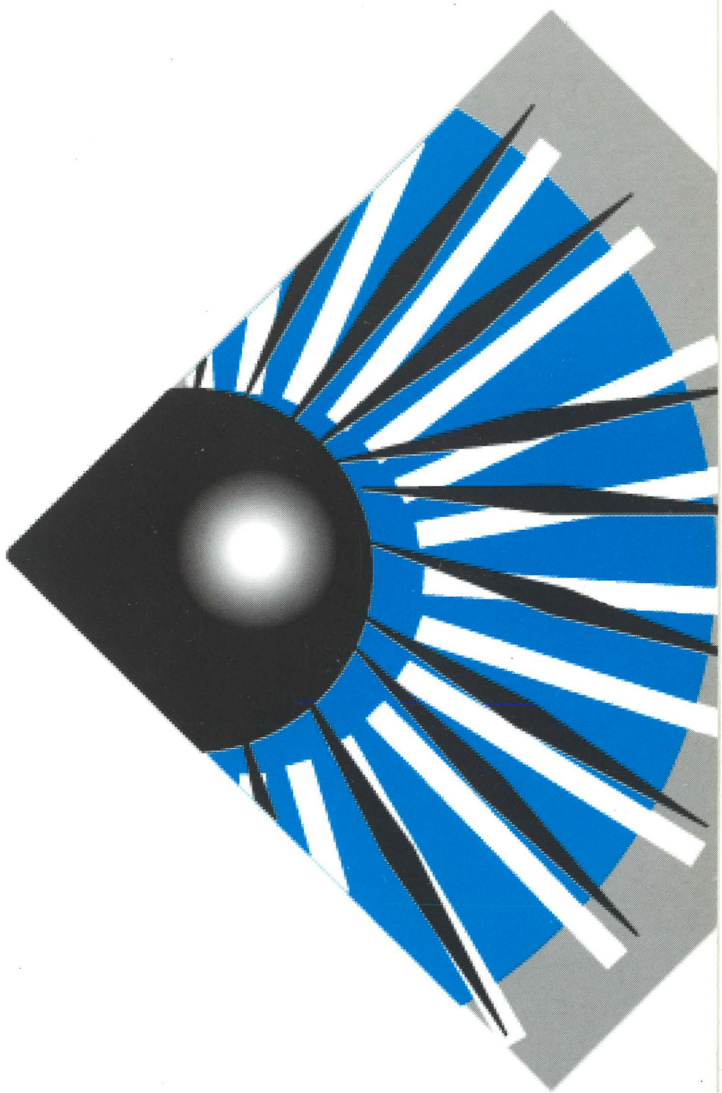

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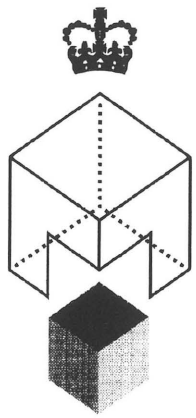

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GLOSSARY OF TERMS

ACCESS DOOR	A door providing access for maintenance or inspection purposes.
AIR CONDITIONING	A form of air treatment whereby temperature, humidity, ventilation, and air cleanliness are all controlled within limits determined by the requirements of the air-conditioned space.
AIR DIFFUSER	A supply air terminal device usually placed in the ceiling and generally of circular, square or rectangular shape and composed of divergent deflecting parts.
AIR FILTER	A mechanical device for removing particulate contaminants from an air stream.
AIR HANDLING UNIT	The assembly of air treatment equipment within one casing. It may include filters, fans, humidifier, cooler battery and associated controls.
BACTERIA	One-celled microscopic organisms, multiplying rapidly by splitting into two.
BALANCING	The process of adjusting the rates of air flow to achieve specified values.
CALIBRATION	All the operations for the purpose of determining the values of the errors of a measuring instrument.
CASSETTE UNIT	A type of split packaged air conditioning in which the internal unit is mounted in the ceiling (recessed into the ceiling void).
CLIENT	The person(s) having control over the premises (including control exercised through a third party).
COIL	A heat-exchanging battery made of tubing formed into a compact shape by spiral or serpentine configuration.
COMMISSIONING	Adjustment of the various controls of an installation to meet the design intent and the recording of the results.
CONTRACTOR	Any person carrying out work on behalf of a client, where that person is not an employee of that client.
DAMPER	A blade or set of blades that can be moved within a duct in order to control air flow rate.
DETERGENT	A cleansing agent, which may be solvent or water based, for removing dirt.
DIRT	Dry dust and debris.
DIRT TRAPS	Those parts of the system prone to heavy dirt accumulation.

DISINFECTION	A process to reduce microorganisms to an acceptable level.
DUCT	An enclosure of any cross-sectional shape, but generally circular or rectangular, through which air can flow.
DUCTWORK	A system of ducts for distribution or extraction of air.
EXHAUST HOOD	A hood associated with an extract system into which contaminated air and entrained solid particles are accelerated.
FAN	A rotary machine for propelling air or gas.
FIRE DAMPER	A mobile closure within a duct which is operated automatically or manually and is designed to prevent the passage of fire.
FUNGI	Plants without chlorophyll, including moulds and mildew.
FUSIBLE LINK	A safety device having a low temperature melting point release mechanism.
GREASE AIR FILTER	A washable filter normally located within the hood over kitchen appliances.
GRILLE	A mesh or lattice entry or termination fitted to a duct.
HAZARD	A situation or source of potential harm which, if realised, could result in injury or ill health to humans, or damage to the natural or built environment.
HEPA AIR FILTER	High Efficiency Particulate Arrestance filter.
MONITORING	Continuous observation of a variable.
PATHOGEN	Any disease-producing microorganism.
PLENUM	A void forming part of the air distribution system.
SHALL	For the purpose of this specification "shall" is used as a mandatory requirement to comply with this specification.
SHOULD	For the purpose of this specification "should" is used for recommended practice to be adopted.
STERILE	Complete absence of any microorganisms.
VAV SYSTEM	Variable air volume system of air conditioning in which a single main duct is run from the central air handling unit and the quantity of air supplied to each branch duct is varied.
VENTILATION	The supply and removal of air to an enclosed space, sufficient for the needs of the occupants or the process.

LIST OF ABBREVIATIONS

ACOP	Approved Code of Practice
BSRIA	Building Services Research and Information Association
CCTV	Closed Circuit Television
CIBSE	Chartered Institution of Building Services Engineers
COSHH	Control of Substances Hazardous to Health
EN	European Standard
HSE	Health and Safety Executive
HVAC	Heating ,Ventilating and Air Conditioning
HVCA	Heating and Ventilating Contractors' Association
ISO	International Standards Organisation
LEV	Local Exhaust Ventilation
MSDS	Material Safety Data Sheets
NADCA	National Air Duct Cleaners Association
NAMAS	National Accreditation of Measurement and Sampling
UKAS	United Kingdom Accreditation Service
VOC	Volatile Organic Compounds

1 INTRODUCTION

1.1 SCOPE

This document describes the processes for conducting a ventilation hygiene contract, from managerial issues through to the technical aspects of cleaning. The guidance is applicable to the health and safety requirements of mechanical ventilation systems, including air conditioning. It does not apply to local exhaust ventilation (LEV) for process plant operations; maintenance, examination and testing of these are covered in *Health & Safety Executive HS(G)54* [Ref 1].

The "Client" refers to the person(s) having control over the premises (including control exercised through a third party).

The "Contractor" refers to anyone carrying out work on behalf of a client.

1.2 REQUIREMENT FOR A SPECIFICATION

The condition of ventilation systems has tended to be neglected for several reasons: long lengths of often inaccessible ductwork being out of sight and out of mind; ventilation systems are normally at the limits of an employer's interest and it is only when complaints are brought to management that any interest is shown in the system; a lack of any firm guidelines to inspect, maintain and clean the system.

However, a number of factors have stimulated the growth of air hygiene services:

- Media attention and legislation have contributed to building owners and operators becoming increasingly aware of their responsibility for maintaining a safe and healthy working environment.
- The increasing complexity of building services, particularly in commercial buildings, has reduced the ability of the owner or operator to service his own plant.
- A trend for building refurbishment frequently includes cleaning existing ventilation systems.
- Risk of litigation over neglect.

Against this background facilities managers will need a specification for ventilation hygiene as part of their overall building management programme for the following reasons:

- Facilities managers may have little knowledge or experience of building services.
- The Health and Safety Commission's *Approved Code of Practice* L24 now specifies maintenance and cleaning practices to comply with the *Workplace [Health Safety and Welfare] Regulations 1992* [Ref 2].
- Facilities managers will need to assess the competency of companies and the validity of any advice offered when undertaking such services.

- Insurers are keen to see ventilation cleaning to reduce health and fire risks.
- Facilities managers need to know how to interpret and act upon hygiene survey reports.
- Environmental accreditation of buildings requires regular hygiene checks as part of healthy building indicators.

The *Standard Specification for Ventilation Hygiene* [Ref 3] and the following guidance are designed to help facilities managers procure ventilation hygiene services from contractors working to the best current practices.

2 MANAGEMENT OF VENTILATION HYGIENE

2.1 ORGANISATIONAL FACTORS

Records

The Client should compile records of existing plant and update these records as and when alterations are carried out.

Records should include the following:

- a schedule of all Heating Ventilating & Air Conditioning (HVAC) systems under the Client's responsibility
- records of each system including ductwork drawings, manufacture/supplier details of plant, serial numbers, spare parts codes, filter efficiency and other relevant details
- a schedule of components for each individual system including length, size and type of ducting, quantity, size and type of extract grilles/supply diffusers, quantity and type of fire dampers/volume control dampers, air turning vanes, coils, fan coils and other items of plant
- positions and sizes of access doors present within the system shown in the record drawings. Additional access doors or alterations should be added to the records as and when changes occur.

*NOTE: **It may be necessary for the Client to enlist the help of a specialist to compile these records.***

Responsibilities

The Client should decide whether to commission a building services consultant or specialist contractor to advise on the management of ventilation hygiene, or whether to deal with it in house.

Before a consultant is employed, it is important that the consultant demonstrates to the Client that he can undertake this type of specialist work. The consultant should have the following credentials:

- knowledge of HVAC systems
- knowledge of legislation regarding HVAC systems
- knowledge of ventilation hygiene techniques
- independence from ventilation hygiene contractors.

Objectives

The Client shall define the cleaning.

Some reasons for cleaning are:

- general maintenance cleaning (current practice)
- removal of hazard (remedial)
  eg cooking fats, bacteria/fungi, mineral fibres, fire/smoke contamination, water, high levels of dust and debris
- loose asbestos fibres within the system (this will require a specialist in asbestos removal)
- refurbishment of systems
- precommission cleaning.

Once the objectives have been defined, the Client should write a brief to define the actual scope of the works.

Frequency

For general maintenance cleaning it is necessary to establish the frequency with which each component within a system should be cleaned. The frequency should be based on a number of factors, including: potential for dirt accumulation, usage, hazard, cost, monitoring and inspection.

Guidance on the potential for dirt accumulation is given in Appendix A (Pages 44-45).

Tendering

Important points to be considered:

- who to select for tendering (check: references, knowledge of HVAC hygiene, company history)
- ease of evaluation
- flexibility of implementation
- confidentiality
- schedules of rates
- procedure for checking and approving completed works
- insurance requirement.

It would be normal for a contractor to visit the site prior to submitting a tender in order to compare site conditions with drawings and to satisfy himself of prevailing conditions.

2.2 INSURANCE

Insurance is essential for the protection of people, property, the environment and business.

Contractor's liability insurance

Appendix B, (Pages 48-53) includes an example of a questionnaire sent by a Client to a Contractor's insurer to ascertain details of their insurance arrangements including any excesses. Section 7 of the questionnaire should be completed by the Contractor's insurer or the authorised representative of the insurer. The following gives the Client some background to why the questions are asked and to stress the importance of getting the cover right before work starts.

Insurance company

If the insurance company is unknown to the Client, he should seek advice from his insurance broker. It is unlikely that the insurer will prove unacceptable but it is a prudent action.

Business description

The policy must clearly define the business of the Contractor. The Client should ensure that the work being done is included within the description.

Renewal date and date premium paid

If the premium is not paid then no cover is in force. If the Contractor's Liability insurance is renewable during the contract period, the Client should ensure that confirmation and continuation of cover is provided on the same basis as before the expiry of the insurance.

Principal clause/memorandum

This joins the Client and Contractor together provided the Client abides by the terms and conditions of the Contractor's policy. It is essential that this is part of the policy.

Extension to cover liabilities to labour-only Subcontractors

The Liability policy must extend to provide legal liability insurance to labour-only Subcontractors.

The Public Liability policy must also be extended to include labour-only Subcontractors (and bona fide Subcontractors) in respect of accidental injury to Third Parties and damage to Third Party property. If it is known that bona fide Subcontractors will be working on the contract then an insurance questionnaire should be completed by them.

The Client should ascertain the "status" of the persons who will be working on site and that they have all undergone adequate training.

Policy restrictions

If there are any policy restrictions then they may limit the business as defined in the business description and hence the cover provided.

Examples are:

Height and/or depth limit, rope access work, hot working, exclusion for damage to property being worked upon, pressure jetting excluded, use of certain chemicals excluded.

Policy warranties

The Contractor must strictly and literally comply with any warranties that are included within the policy. Failure to do so could make void the policy.

Examples of warranties are:

Hot work warranty in respect of the use of heat away from the Contractor's own premises, warranty that suitable personal protection equipment be worn by persons carrying out hazardous work.

Employer's liability insurance

This provides the Contractor with legal liability indemnity in respect of accidental death, injury or disease to employees arising out of their employment.

The minimum value limit of indemnity for any one accident is governed by the *Employers Liability (compulsory insurance) Act 1969*, which states £2 million. However, in practice, the usual limit is £10 million but higher limits are available.

The Client has a responsibility to provide similar conditions in respect of health, safety, welfare and security for the Contractor's personnel in the same way as for the Client's own personnel.

Public liability insurance

This provides legal liability indemnity in respect of accidental death or bodily injury to Third Parties, or accidental loss or damage to Third Party property arising out of the course of the business (as defined in the Business description).

Limit of indemnity should correspond with the Clients company's requirements. Insurers may recommend £2 million in respect of any one accident and unlimited in any one year. However, some organisations seek £10 million or more.

If a Contractor carries a limit of indemnity of £1 million it is possible to increase the indemnity by payment of an additional premium calculated on the period of the contract and the excess indemnity required over £1 million.

The Third Party property damage section is usually subject to an excess (Employer's liability is not subject to an excess generally).

Further extensions of cover are available which may be applicable to the contract and are as follows:

- fire and explosion
- vibration and weakening of support, subsidence and/or collapse
- contractual liability
- damage to property on which work is being carried out
- damage to property temporarily in the Contractor's care, custody or control
- extension of the policy to include bona fide Sub-Contractors.

Products liability insurance

This is normally an extension of the Public Liability policy.

Cover is provided for the Client's legal liability in respect of accidental injury or damage to Third Parties caused by products supplied or by completed work.

Limit of indemnity is usually the same as the Public Liability policy but it is "in the aggregate any one year" and not "any one accident".

Contractors all risks insurance

Protects the contract works on an "all risks" basis as defined in the policy. It also provides cover in respect of the Contractor's plant and an employee's tools.

Policy is subject to an excess.

The security and fire protection of the site are the responsibility of the Client and Contractor.

Professional indemnity insurance

If, as part of the Client's risk assessment, paid professional advice is sought then the Consultant should provide the Client with evidence that Professional Indemnity Insurance is in force up to a limit that complies with his own company's requirements.

If advice is given by the Contractor who does the work then the liability is picked up under the Public Liability policy provided the advice relates solely to the contract. The indemnity provided only relates to accidental injury to Third Parties or damage to Third Party property.

The limit of indemnity is usually "in the aggregate in any one year" and not on an "any one claim" basis.

Client's business insurance

Property

If any fire alarm/extinguishment, explosion suppression, or security device ie sprinklers, fire dampers, alarm etc, needs to be deactivated, the Client's insurer must be advised prior to work commencing. Failure to do so could cause difficulties in the event of a claim.

If the ductwork needs to be "cut into" and/or altered physically in any way to aid the cleaning process, especially near fire-resisting construction where fire dampers operate, then the Client's property insurers need to be advised.

Fire insurance surveyors carry out periodic surveys and it is essential that records are kept of when the ducting was last cleaned. It is important in relation to high risk areas (see page 28) and, in certain cases, records must be kept safe for at least five years.

Liability

If substances which are subject to the COSHH Regulations are to be used, the Contractor and the Client must be fully conversant with the risks to health, safety, property and must be aware of necessary precautions.

Supplier's Materials Safety Data Sheets and container labels are the initial point of reference. Additional information can be obtained from the Health and Safety Executive document *"A Step by Step Guide to COSHH Assessment"* [Ref 4].

At the end of each contract stage, the system should be handed over in an acceptable condition.

A Certificate of Cleaning should be issued upon completion of the cleaning contract (see page 38).

The responsibility for waste material following the cleaning shall be clearly defined (see Page ii, and Section 10 in *"Standard Specification for Ventilation Hygiene"*).

Environmental issues, eg pollution, hazardous materials, noise, need to be considered in relation to Third Parties and surrounding property before work commences.

The Client is responsible for providing an efficient (in terms of health and safety) environment for the workforce. If this is not the case then there is the possibility of an action being brought by persons should they suffer illness or disease, or by the Health & Safety Executive.

Following an incident that could give rise to a claim

The Client should:

- Implement contingency plan procedures, of which insurance should be a part.
- As soon as possible, take pictures of the incident and mark them with the location, date and time.
- Make a written record of what has happened and take statements from those involved.
- Contact his Insurer via his insurance broker where appropriate.
- If he feels that the Contractor is at fault, lodge a claim on seeking advice from a legal adviser if appropriate,.
- Have available copies of the contract, insurance details, permit to work, cleaning certificate and other information which a loss adjuster may require.

No permission to start work should be issued until the Client or his professional insurance broker are satisfied that the insurance arrangements meet the requirements as set out in the tender document.

2.3 COMPETENCY OF CONTRACTOR/ CONSULTANT

The Client should establish the competency of any Contractor, whether offering advice or physical works, to ensure they are competent to carry out such work. This can be achieved by collecting relevant information from the Contractor (see questionnaire in Appendix B, pages 48-53).

3 INSPECTION, SAMPLING AND TESTING

This relates to the activities in management control of indoor air quality and system condition as referred to in the decision tree, (see Figure 3.1) and can form part of the risk assessment and continuing monitoring.

A set rationale should be followed when commissioning a condition survey or continuing monitoring programme. Results recorded from measurements taken on site, and samples analysed in the laboratory should be accurate and reproducible. All measuring and sampling equipment used must be periodically serviced, maintained and regularly calibrated to recognised standards.

Methods and equipment used should remain constant for any monitoring programme as the interpretation of results and the decision to instigate remedial action will often be based on changing trends between different periods of monitoring, ie the decision to clean all or part of the system may be based on a significant deterioration in air quality or system condition demonstrated over a period of time.

The following tests will provide detailed data on the quality of air being supplied by all or part of a system and its structural integrity. A report should be submitted to the Client detailing the results of inspection and sampling; this will form part of the management control process.

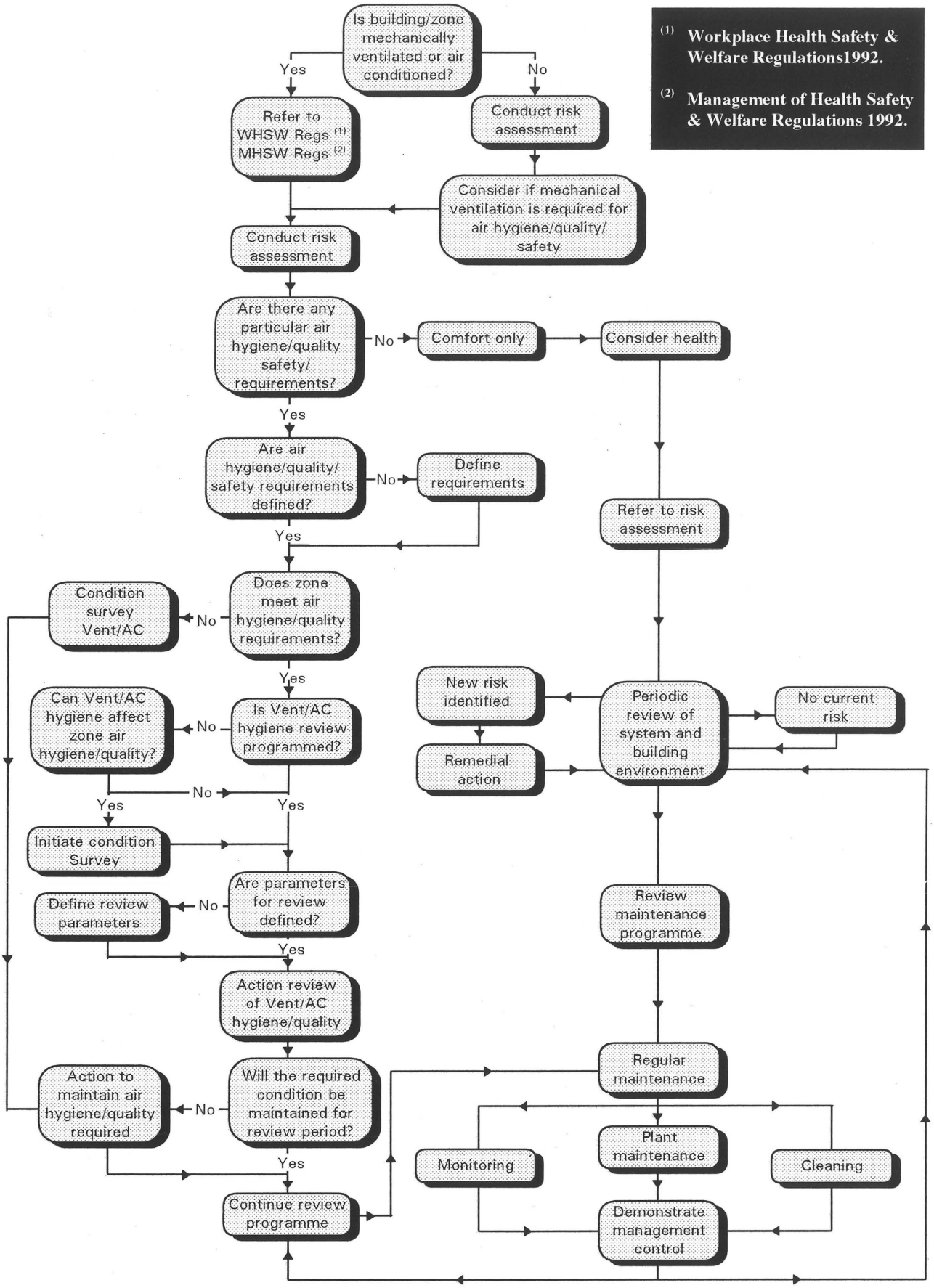
The information collected should make clear whether all or part of a system requires cleaning.

3.1 VISUAL INSPECTION

A representative amount of the system should be examined wherever possible using existing access points, borescopes or remote control cameras to inspect the more inaccessible areas. Comments should be made on the condition and cleanliness of the surfaces, with the use of test results, photographs or videos to support findings.

A detailed examination should also be carried out of the corresponding air handling plant, both main and terminal units,. This should include fresh air intakes/chambers, ductwork, filtration arrangements, fans, fan coil units and fan housings, sound attenuators, heaters and/or chillers, humidification chambers, grilles etc. The structural integrity and cleanliness of the plant will indicate how well the system has been maintained, which in turn will have an influence on the cleanliness of the ductwork. Indicators of poor maintenance which may have a detrimental affect on the ductwork system are ill-fitting or absent filters, build-up of dirt/debris, corrosion, scale, flaking paint, damaged and shredding internal insulation material and condensation. The presence of contamination or structural damage downstream from the filters is obviously of greatest concern.

Figure 3.1 Decision tree for ventilation hygiene health and safety



3.2 MONITORING AIR QUALITY

The relationship between levels of ventilation system cleanliness and the health of building occupants is not always direct nor is any correlation well defined. Similarly there is no direct relationship between indoor air quality and levels of surface contamination of ventilation systems. However monitoring of air quality and/or surface contamination levels can give a useful indication of the condition of the ventilation system and its performance.

There are at present no specific standards for sampling or measurement techniques and protocols, or analysis regimes, nor for the interpretation of the results obtained. It therefore falls to the Client and the Contractor to agree with the advice of an expert how sampling and/or measurement work will be undertaken. The performance of the Contractor and the sampling method should be audited by a third party to ensure consistency and reproducibility. Organisations such as those accredited under the United Kingdom Accreditation Service, ie the National Accreditation of Measurement and Sampling (NAMAS), run stringent systems to ensure suppliers of such services meet pre-determined performance standards. The ability of contractors to satisfy such organisations and therefore retain accreditation for the services they supply should be used as a measure of competency by the Client.

Any sampling or measurement of indoor air quality or level of ventilation system contamination shall only be carried out after the Client and the Contractor have specified the following issues:

- who shall carry out the sampling, including their competence
- what sampling and measurement is to be done, eg particulates (airborne or surface), micro-organisms, carbon-dioxide etc
- how the samples or measurements are taken, eg the use of suitable, accurate and calibrated equipment
- how many samples or measurements are taken
- when the samples or measurements are taken
- where the samples or measurements are taken
- how the samples or measurements are analysed, eg use of accredited laboratories
- how the sample and measurement results are prepared and produced in the final report
- how the sample and measurement results are recorded
- any particular organisational or health and safety issues which might affect those carrying out the sampling and measurement or those in the building when the sampling and measurement is being carried out.

The Contractor should be able to explain and support the rationale for the particular sampling and measurement protocol adopted.

Most importantly before sampling or measurement is undertaken the Client and the Contractor should agree in detail the interpretation of the results obtained; in particular they should agree what actions, if any, should be undertaken at any pre-determined sampling or measurement result. For example at x mg/m^3 the next inspection interval can be extended to 18 months, or at y mg/m^3 the air handling and filtration plant must be thoroughly examined and any remedial work carried out, and the ducting in the building is cleaned using method A (see Page 17).

4 LEVEL OF CLEANLINESS

There are no UK standards governing acceptable levels of cleanliness for ventilation systems. Some installations may require a higher level of cleanliness than others where "visibly clean" is sufficient.

4.1 VERIFYING DUCT CLEANING

Verifying that cleaning has been carried out effectively should be included in any contract for ventilation cleaning.
It is essential for the Client to specify the level of cleaning and verification to ensure fair and accurate evaluation of competing tenders. (see Section 4.5)

For larger contracts the Client may wish to appoint an independent body to confirm that cleaning has been carried out in accordance with the contract requirements.

Verification can be made by visual observation or by a test method which compares the amount of dirt remaining on cleaned surfaces to a defined contamination level. It must be remembered that air cleanliness is not directly related to the surface cleanliness of ductwork.

The level of cleaning required and verification method should be appropriate for the function of the system and workplace served.

4.2 VERIFICATION BY VISUAL EXAMINATION

Internal examination should be at a specified minimum number of locations to include obvious dirt traps, and a **subjective assessment** made as to how much surface is free of removable dirt. A minimum percentage of locations achieving a specified percentage free of removable dirt should be set as the level of cleanliness required.

4.3 VERIFICATION BY SURFACE TEST METHODS

Two tests can be used to determine how well a duct surface has been cleaned:

- measuring the amount of *dirt* per unit area of duct surface
- measuring the amount of *bacteria* and *fungi* per unit area of duct surface where disinfection has formed part pf the cleaning operation.

Surface dirt measurement

A measured area of duct surface, usually defined by a mask, is subjected to recovery of dirt, and the weight of dirt per unit area gives an indication of surface cleanliness.

The dirt recovery may be by a vacuum filter device or by wiping, and the weight of dirt determined by comparing the weight of the collecting filter or wipe before and after dirt collection.

Vacuum filter methods may not be effective at collecting residual dirt if the surface of the duct is greasy or damp. The rate at which the suction unit is passed over the sample area can affect efficiency, as can pump suction and volume setting. A vacuum test method has been developed by NADCA (National Air Duct Cleaners Association) a United States based association of duct cleaning contractors. This is sometimes referred to in specifications [Ref 5].

Wipe methods require a consistent efficacy of wiping and wipes can be moistened to increase the collection of adherent dirt. Some contractors have developed wipe verification methods.

Given the differences in collection efficiency it is not possible to compare verification results obtained by different methods.

Microbiological surface sampling

The number of viable bacteria and fungi on a unit surface area can be obtained by swabbing a defined area and culturing, or by using a contact sampler to recover organisms for incubation and subsequent counting and possibly identification.

Significant counts of bacteria and fungi can be recovered from visually clean surfaces and the cleaning operations may even increase counts locally. Microbiological sampling is therefore only valid for verifying that cleaning together with disinfection, or disinfection alone, have been carried out.

Various sampling devices and different nutrient media are used and laboratory processes may vary in delay between exposure and processing and in the temperature and duration of incubation employed. Therefore results from different methods and materials cannot be compared. Any laboratory used should have a recognised quality standard.

4.4 TIMING OF TESTS

It is essential that verification tests are done immediately a duct section has been cleaned or disinfected since using the system or the occurrence of draughts may introduce dirt back into the ducts.

4.5 LEVELS OF CLEANING

Typical cleaning levels for non-porous duct surfaces given below may include additional verification methods as appropriate.

Extract ducts discharging to atmosphere

Removal of gross contamination and loose materials and removal of objects likely to fall or blow back into the ventilated space or be a fire hazard or obstruct air flow or interfere with the operation of controls, sensors of fire dampers. A visible residue of dust or manufacturing oil/grease may remain after cleaning.

This type of system is liable to recontamination very quickly, making frequent less rigorous cleaning more economic than occasional more rigorous cleaning. Periodic cleaning should be included in maintenance schedules.

Extract ducts handling air which is returned to the ventilated space after filtration

To be generally free from a uniform coating of fine loose dust but some traces of residual dust may remain covering less than 10% of any section inspected. A fine film of residual manufacturing oil/grease may be visible.

This type of system may be liable to recontamination very quickly, making a frequent less rigorous cleaning more economic than occasional more rigorous cleaning. Periodic cleaning should be included in maintenance schedules

Supply air ducts for general factory, office or public areas without defined air cleanliness

To be essentially free from visible dust. Negligible traces may be found in crevices, corners or at obstructions. A fine film of manufacturing grease may remain.

Supply air ducts to areas having defined air cleanliness

To be free from all visible dust and manufacturing grease and conforming with defined cleanliness criteria. This is only recommended for ductwork downstream of filters of H10 and upwards.

5 CLEANING METHODS

The following is a brief description of current techniques used during a cleaning operation. Advances in technology mean that this list should not be considered exclusive. Table 5.1 gives guidance on possible cleaning methods for the various components of ventilation plant. A combination of these should be used depending on the standard of cleanliness required.

Manual vacuuming [A]

Using dry or wet suction cleaners with bristle brushes ductwork which contains dry atmospheric deposits can be cleaned to a high standard.

Hand wash/wipe [B]

A simple wiping process is used in certain instances, using cleaning agents where required.

Hand wipe in clean room environment [C]

When it is essential that particles are removed to clean room standards, manual vacuuming is followed by a thorough hand wipe with specifically designed materials. "Takrags", anti-static dusters, lint-free cloths and specialist cleaning solutions are typically materials used for this high grade clean.

Steam washing [D]

Where grease or heavy atmospheric deposits are present, more aggressive techniques are required. Selected cleaning agents are used to break down the deposits, reinforced by high pressure water and steam washing at temperatures up to 150°C and followed by a thorough rinsing. Client and Contractor should be aware of industry codes. The effluent created is either directed into collection barrels using sheeting methods, or collected with wet suction cleaners. It is then subsequently neutralised and disposed of via the Client's drains, if acceptable to the Client and the local water undertaking. Care should be taken to prevent damage from possible leaks at duct joints.

Chemical spray [E]

Heat exchange coils and ductwork can be sprayed with a specially formulated cleaning agent which breaks down the adherent properties of any stubborn deposits. All cleaning effluent shall be disposed of according to the manufacturer's recommendations and in accordance with appropriate regulations.

Mechanical brushing [F]

Smaller sections of ducting can be cleaned using this technique. Flexible brushes of varying length, diameter and bristle grade are chosen to suit the duct to be cleaned. It is essential that the brushing system used is capable of agitating all internal surfaces of the ductwork, whether circular, oval, rectangular or square. This is normally accompanied by a sectional extraction technique.

Air jetting [G]

All types of ductwork can be cleaned using high volume and high pressure flexible air jetting devices. This is normally accompanied by a sectional extraction technique. Coils can be cleaned using compressed air.

High volume air blast [H]

Using a limited amount of injection points, generally in the plant room ducting, air at high volume and pressure is fed into the ducting whilst the system is running, which considerably increases the air velocity through the ducting. Most of the loose deposits are collected by filter media which are fixed over the outlet and inlet points. This technique has limited application and is not normally used in commercial buildings.

Sectional extraction [I]

The ductwork is cleaned in sections to maximise the extraction velocity. Mobile extraction units are used to create sufficient air flow whilst air jetting and rotary brushing remove the loosened deposits. The dirt-laden air which is extracted from the ductwork is passed through a dust collector to remove the particles before being exhausted. If the building is sealed then the air will pass through a series of filters, the grade of which depends on the Client's requirements. Generally a pleated type panel or a high efficiency bag filter is sufficient; however in certain clean room environments it might be deemed necessary to utilise an additional high efficiency filter to remove the ultra fine particles from the discharge air.

Sectional blocking [J]

As a cleaning operation progresses it is necessary to seal off certain sections of ducting once cleaned to prevent cross-contamination. For example high density 4" foam blocks or sometimes tight-fitting air bags of varying sizes are used to seal off cleaned areas. This technique also assists in creating maximum extraction velocity.

Sealing or Encapsulation [K]

In certain circumstances such as poor accessibility, cleaning to ultra deep levels or where fibrous linings are present, it might be deemed necessary to apply a sealing solution. The sealant will prevent movement of any remaining particles, although dirty surfaces may prevent proper adherence of the sealant. Consideration should be given to acoustic properties of coated internal insulation, fire safety and the potential for off-gassing.

Hand scrape [L]

Surfaces with heavy sticky deposits, such as those within a kitchen extract system may undergo an initial scraping process with stiff (1" to 4" wide) steel scraping tools to reduce deposits to a fine film prior to other finishing techniques.

Table 5.1

Possible cleaning techniques for components of ventilation plant

Air handling unit	ABCDJK
Large ducting (Above 400mm x 600mm)	ACGHIJK
Small ducting (Below 400mm x 600mm)	ACFGHIJK
Large circular ducting (Above 800mm dia.)	ACGHIJK
Small circular ducting (Below 800mm dia.)	CFGHIJK
Extract grille and baffle	ABDK
Supply diffuser and baffle	ABDK
Flexible ducting	DFGHIK
Air turning vane or flow straightener	ABCHK
Volume control damper	ABCHK
Fire damper	ABCHK
Silencer or attenuator	ABCGHIK
Plenum (ceiling and floor)	ABCHK
Mixer box (Dual duct)	ABCGHIK
Re-heater/chiller coil	ADEGH
Extract fan	ABCDEGHK
Induction unit	ABCDGHIK
Sensor	ABCGHI
Kitchen extract fan	ABCDL
Kitchen extract ducting	ABCDL
Kitchen extract canopy	ABCDL
Grease filter	D
Air filters (When spares not available)	ABC
Short spigot to diffuser or grille	ABK

A = Manual vacuuming
B = Hand wash/wipe
C = Hand wipe in clean environment
D = Steam washing
E = Chemical spray
F = Mechanical brushing
G = Air jetting
H = High volume air blast
I = Sectional extraction
J = Sectional blocking
K = Sealing or encapsulation
L = Hand scrape

NOTE: *In the absence of independent verified tests, this table can only serve as a guide.*

5.1 ALLIED CONSIDERATIONS

A number of important factors should be considered by the Contractor.

Cleaning agents

When cleaning agents are used and dust created, the implications of the COSHH Regulations shall be considered.

Access points

It is important that a ductwork system has sufficient access points to allow cleaning of the internal surfaces and components. The position, size and type of access point should be selected taking account of the cleaning techniques. It may be possible to use existing access points such as flexible connections, grilles and diffusers, and end caps.

Access doors should be fitted on either side of any obstructions, such as air turning vanes, dampers, tees and silencers. Access points should not be obstructed.

Access doors should be chosen taking into account:

- thermal properties to equal or exceed that of the ductwork and any insulation
- suitable sealing gaskets to prevent air leakage
- quick release retaining catches
- hinges for large air handling unit doors
- retainer chains for high level points.
- air pressure within the system
- kitchen extract (see Section 5.2).

Where existing doors are covered by insulation or weather and fire protection their position should be clearly labelled for future use.

When access doors are hidden (ie by false ceilings) labels should be used to identify their location.

It should be noted that under the *Construction Design and Management Regulations 1995* [Ref 6] sufficient access doors should be installed and their position clearly marked to enable cleaning to be carried out.

Floor and ceiling voids and plenums

Consideration should be given to include cleaning of non-galvanised sheet steel plenums such as plant rooms, builder's work shafts, ceiling and floor voids. These voids are formed by a false ceiling or raised floor to create a space for the services including ductwork. Access through the false ceiling or floor must be provided adjacent to ductwork access panels and be clearly marked. This access may be by the lifting out of removable tiles or by a permanent access door through a solid or interlocking structure.

In many instances these voids are used as a supply or return air plenum where the void itself is used as part of the system. In this situation the void will become contaminated with dust and debris in the same way as the rest of the system and may require cleaning. The Health and Safety Executive consider such voids part of the ventilation system. Early installations often used asbestos-based products, in which case the appropriate precautions must be taken.

Care must be exercised when removing floor or ceiling panels to ensure that any contamination does not enter the ventilated space. Care is also required to ensure the tiles are not damaged or marked in the removal/cleaning/replacement process.

Suspended ceilings

In many cases, ductwork is concealed behind a suspended ceiling and/or below the floor slab. Where solid or interlocking tiled ceilings are used, it is important that permanent access points are provided through the ceiling adjacent to ductwork access doors, to allow easy accessibility.

Care must be exercised when removing ceiling tiles to ensure no damage is done and there is no fouling on the visible side of tiles.

Silencers

These are purpose-designed structures installed in ductwork for the suppression of noise. The sound-absorbing material is formed into panels usually contained between perforated plates. For effective operation the air spaces between panels and the holes in the perforated plates should be free of contamination.

Cleaning is normally by air jetting and/or brushing together with vacuuming. Wet cleaning methods should not be used as they are likely to cause the sound-absorbing material to collapse and thus render the silencer ineffective.

In kitchen extract systems grease will enter the sound absorbing materials through the perforated plates. The silencer material should be installed to allow for easy removal for cleaning and the sound-absorbing material sealed in a material such as Melenex suitable for wet/steam cleaning.

Dampers and flow baffles

Before commencing the cleaning operation, all dampers and baffles should be marked at their "as found" setting, as a reference point to return the dampers to their original setting following completion of cleaning.

Spray paint, indelible markers or scribers should be used to record settings; it is important that the chemicals used during a cleaning operation do not remove these reference points, (see also Section 13, page 37).

Fire dampers

Any debris or obstructions found should be removed to allow the fire damper to fully close in the event of a fire. The Client may specify testing the operation of all fire dampers as part of the contract. The Contractor should report all faults found.

Porous linings

Internally lined ductwork is difficult to clean, such linings harbour deposits, moisture, bacteria and fungi. The linings often suffer fatigue, detachment from ductwork and crumbling, allowing particles to be blown within the airstream and out of the diffusers. It is extremely difficult to clean lined ductwork without causing damage. Consideration should be given to removal of porous linings during a cleaning operation.

Riser shafts

Riser shafts should incorporate access doors at every floor. If a riser is external to the building, provision for safe access should be made. For risers over 800mm x 600mm it would be possible to clean by an industrial abseiler, hence avoiding the need for access points on every floor, but three independent secure fixing points would be required at high level adjacent to point of entry, and access doors would be required at high and low level.

Filtration

The quality of the filtration used in a ventilation system, its proper installation and correct and timely maintenance, will materially affect the quality of the air in the system and decrease the frequency of cleaning. Enhancing the efficiency of a system is recommended, particularly in older systems.

The ability (efficiency) of a filter system to remove dirt and other particles from the air varies by type of filter and the media used. To allow better comparison a European Standard (EN779) grades filters on a scale of G1-G4 for coarse filters and F5-F9 for fine filters; the higher the grade the better the filtration efficiency.

Table 5.2 shows the main types of filtration provided in ventilation systems.

Table 5.2
Filter grading

Type of filter	Efficiency	EN779 Class
Panel	Low	G1 - G4
Bag	Medium/High	G4 - F8
Rigid Cell	Medium/High	F5 - F9
Semi-HEPA & HEPA	High	H10 - H 14 (EN1822 provisional)

Often a combination of filters is used, with pre-filter protecting a higher efficiency main filter. This may be typically a panel filter followed by either a bag or rigid cell filter. The low cost, low efficiency panel filter will remove most large particles and some small particles, the main filter will provide the final level of filtration required. In this way it will be the low cost pre-filter that will be changed more often, keeping running cost to the minimum. Special filters may be required for some installations (eg kitchen, process, or fume extract).

In some older installations roll filters and viscous (oil bath) filters may be found and consideration should be given to their replacement.

The disadvantages of using higher efficiency filters are:

- higher first cost and replacement costs.
- higher system energy consumption.

The advantages are:

- a cleaner system
- improved air quality (this is recognised as a prime factor in reducing *Sick Building Syndrome*)[Ref 7]
- a potential reduction in operating costs due to longer periods between system inspections and the need for system cleaning.

Since filter selection is a detailed procedure, further advice may be sought from the *CIBSE Guide* [Ref 8] and from BSRIA's publication *Air Filters - A Selection Guide* [Ref 9]. Any reputable manufacturer should be able to give appropriate assistance.

5.2 KITCHEN EXTRACT SYSTEMS

A regular cleaning programme for the entire extraction ductwork, canopies and mechanical equipment associated with kitchen extraction may be required to reduce hazardous risks. Fire dampers should also be subject to routine maintenance. To prevent the build-up of fatty deposits and dust in the duct system a minimum two stage air cleaning system is required, with an optional third stage odour control filter.

The most troublesome kitchen extract systems are those directly serving the cooking appliances, especially where atomised cooking fats, oils and greases are generated. The aerosols are drawn into the extraction system through the low efficiency metal filters (G1/G2). These filters entrap larger particles but fumes and fine dust will pass into the ductwork, leaving fatty deposits on internal surfaces, and which may reach the impeller blades of the extract fan. In extreme conditions the fatty contamination will leak out at bends and joints in the ductwork giving rise to unacceptable conditions in ceiling voids, plant rooms, and the food processing areas. The use of rigid F7 grade filter cells after the metal filters will prevent this problem. Neglecting extract systems can be a fire hazard, health risk, source of odours and require costly repairs.

A typical three-stage air cleaning and filtration system is:

1)	**Metal grease filter**	**-**	**pre-filter and fire control**
2)	**F7**	**-**	**coalescing fumes, droplets and dust**
3)	**Adsorber filter**	**-**	**(optional) for odour control**

Risks

Fire hazard

The combination of accumulating fats, oily deposits, greases and fibrous particles is highly combustible. The extract fan supplies forced air, while the cooking appliances provide a source of ignition.

Fire officials cite neglected grease extract systems as the major cause of spreading fire in catering establishments.

NHS Estates Fire Practice Note 4 [Ref 10] states:

"Fire involving a deep fat-fryer and its extraction system may develop very rapidly and reach a stage of such violence that it cannot be contained within the main kitchen and perhaps not even within the catering department.

A fire hazard can be created in ventilated ceilings by the accumulation of greasy dirt, aggravated by the intrusion of other building services, involving pipework for example, and where cassettes are not cleaned regularly.

A high standard of maintenance of extract systems, in particular those serving deep fat-fryers, is essential in order to prevent fires starting, and to restrict their effects should they occur. Grease extraction filters can become progressively greater fire hazards with use, and must receive regular inspection and cleaning. Internal cleaning of ductwork must be undertaken as part of the planned maintenance system.

Provisions to avoid the occurrence of fire in ventilated ceilings and to contain them are as follows: All cassettes must be easily removable for frequent cleaning and it should be possible to gain access to each void for the purposes of inspection and cleaning".

Health hazards

A neglected system is an ideal breeding ground for bacteria; should deposits leak out into preparation areas then food may become contaminated. Cockroaches have been found and can thrive in dirty extract systems.

Reduced efficiency

The air flow efficiency can be seriously impaired by deposits on surfaces, and the accumulation of deposits on the fan impeller blades can cause it to run out of balance, resulting in increased power consumption and wear.

Odour

Accumulated grease can become rancid and add to the odour load on discharged air.

Increased capital costs

As with any plant, neglect will reduce the service life. Deposits left in ductwork will become baked on, making removal extremely difficult and time consuming. A poorly maintained system will need replacing earlier than a well maintained one hence increasing capital expenditure over the long term.

Design for ease of cleaning

It should be considered at the design stage whether kitchen extract ductwork is best cleaned using wet techniques, in which case the duct route should be such that water will not cause major problems when the inevitable water seepage occurs during the cleaning cycle.

Quick release access doors should be designed into systems. Such doors should be as large as the duct size permits and generally installed on the side or underside of the duct. Access doors should be positioned on either side of dirt traps (ie air turning vanes, dampers, attenuators, fans), at tee junctions, on bends and at no more than 3 metre centres on straight runs of ductwork below 600mm x 400mm. Extraction fans should be used which allow thorough in situ cleaning of impeller blades and internal surfaces of the fan casing, without the need for a complete strip down.

It is important that access door entry is not restricted.

Frequency of cleaning

A regular cleaning programme should be introduced as soon as the system is put into service, to minimise the problems listed above. The frequency of cleaning should be decided based on **Table A - 3** in Appendix A, also on the type and quantity of cooking being conducted, ie the more fats, oils and greases produced, the more frequent the need for cleaning. As a minimum, a grease extract system in daily use should be completely deep cleaned annually (including canopies, ductwork and extraction fan). Some systems may require more frequent cleaning, as often as every three months. The internals of the canopy would generally require cleaning more regularly than the complete system, ie three canopy cleans for every one complete system clean.

Insurance recommendations

The Loss Prevention Council's *"Recommendations for Cooking Equipment"* [Ref 11] makes the following requirements for kitchen extract hygiene and safety:

"Bends or dips which might collect residues are to be avoided and the whole of the ducting should be accessible for cleaning. At each change in direction of the duct an opening with a grease-tight cover should be provided for the purpose of inspection and cleaning. A residue trap should be installed at the base of any vertical riser.

Cleaning of the surfaces of all cooking equipment hoods and canopies, ductwork, fans, burners, fixed fire extinguishing equipment etc should be carried out at frequent intervals to prevent contamination by grease or oil. Particular attention should be given to concealed areas formed by corners, and grease tends to accumulate at specific points and lips.

Frequent cleaning of filters or other grease removal devices is particularly important. Cleaning intervals depend on the type of equipment and the extent of its use but should not exceed seven days.

Cleaning of filters etc does not remove the need for the periodic inspections of the inside of ductwork and the extraction motor to check for build-up of grease deposits. Cleaning should take place at intervals not exceeding 12 months, preferably by specialist contractors. This may require the cutting of openings in the ductwork if none have been provided. Flammable solvents or other flammable based cleaning aids should not be used".

In the event of a fire, the loss adjuster appointed may request records of the kitchen extract system maintenance, cleaning and inspection.

6 HIGH RISK EXTRACTION SYSTEMS

The following list highlights some workplaces where the extract systems suffer from particularly heavy and/or hazardous depositing. A regular inspection and maintenance programme should be introduced to maintain satisfactory efficiency and minimise risks of fire/explosion, or of vermin contaminating the environment and affecting health.

- Kitchens
- Laundries
- Car parks
- Operating theatres
- Bathrooms/toilets
- Pharmaceutical product lines
- Laboratory fume cupboards
- Wood working machinery
- Tissue paper manufacturing areas
- Paper cutting areas
- Animal houses
- Textile manufacturing
- Flour mills
- Areas involving any food powders
- Areas involving bone dusts
- Shooting ranges.

This list comprises common high risk areas; it is likely that other systems not listed may suffer similar problems. Inspection at least annually of all extract systems is recommended.

7 DISINFECTION

The Contractor or Client may propose disinfection of ductwork and ventilation/air conditioning plant as an adjunct to a cleaning process or as a periodic service activity.

Disinfection should not be a substitute for cleaning, it should be considered where there are particular requirements or hazards. Some plant conditions such as unavoidable wet areas may require disinfection. Risk analysis should be considered at all times. The requirements of the Health and Safety Executives' *"The Control of Legionellosis Including Legionnaires' Disease"* [Ref 12] should be noted.

The objective of disinfection is to reduce colonisation of surfaces by bacteria and fungi. Contaminated systems are capable of releasing organisms and spores into the work space, potentially affecting occupants. Fungal contamination may also generate a variety of volatile organic compounds (VOCs) which may be harmful to health. Particular attention is called for at cooling coils where contaminated condensate can add considerably to the microbiological load.

The World Health Organisation publication *"Indoor Air Quality: Biological Contaminants"* [Ref 13] warns of the possible toxic risk to occupants and cautions against relying upon the routine use of disinfectants. The document does not identify any particular biocides, concentration or application method.

Disinfection should not be viewed as a cheaper alternative to cleaning a dirty ventilation system or eliminating any dampness supporting colonisation. Disinfectants applied to a dirty system are likely to provide little improvement in hygiene.

A number of products can be used for duct disinfection ranging from powerful but hazardous chemicals like formaldehyde or ozone which require very careful control measures such as isolation of the building zone, exclusion of personnel and very thorough venting after application, to much safer products using as active components chemicals commonly used to protect drinking water, protect contact surfaces in manufacture or as components of antiseptic ointments.

The distinction should be noted between:

a) once-off or occasional application of disinfectant and

b) any methods whereby the disinfectant is constantly or regularly introduced into the air supplied by the system.

In the case of a) the occupants can easily be separated from the disinfectant and it is possible to use products which, once disinfection is complete, reduce to a harmless state or are vented away.

In the case of b) applying a disinfectant such as low concentrations of electrically-generated ozone to an air supply exposes the occupants over a long term.

Disinfection should be carried out when the building is normally unoccupied or at minimum occupancy.

Disinfectant can also be applied as a component of paint or coatings applied to surfaces with the intention of preventing colonisation of the treated surface. Occupants will be continually exposed to this via the air passing over such treated surfaces.

8 ELIMINATION OF ODOURS

Odours can develop within a ductwork system for a number of reasons such as:

- smoke contamination from a fire (see decision tree Section 9)
- decaying vermin
- sludge in cooling coil condensate trays
- excess levels of accumulated atmospheric dusts
- accumulation of cooking grease.

Removal of odour is the prime objective rather than masking.

8.1 IDENTIFY SOURCE

A visual inspection of the system can be performed using access openings as inspection points, borescopes or CCTV cameras. The source of the odour can be pinpointed by access points along duct runs; airflow direction must be taken into account.

8.2 REMOVE SOURCE

Physically remove the source of the odour as far as practicable, using appropriate cleaning techniques. Odours may be a result of the siting of air intakes.

8.3 ODOUR REMOVAL

In some instances, after source removal, there may be a trace odour remaining. To remove the remaining odour it may be necessary to treat the affected areas with an odour-neutralising chemical or gas applied by pressurised spray or fogging techniques.

8.4 ODOUR MASKING

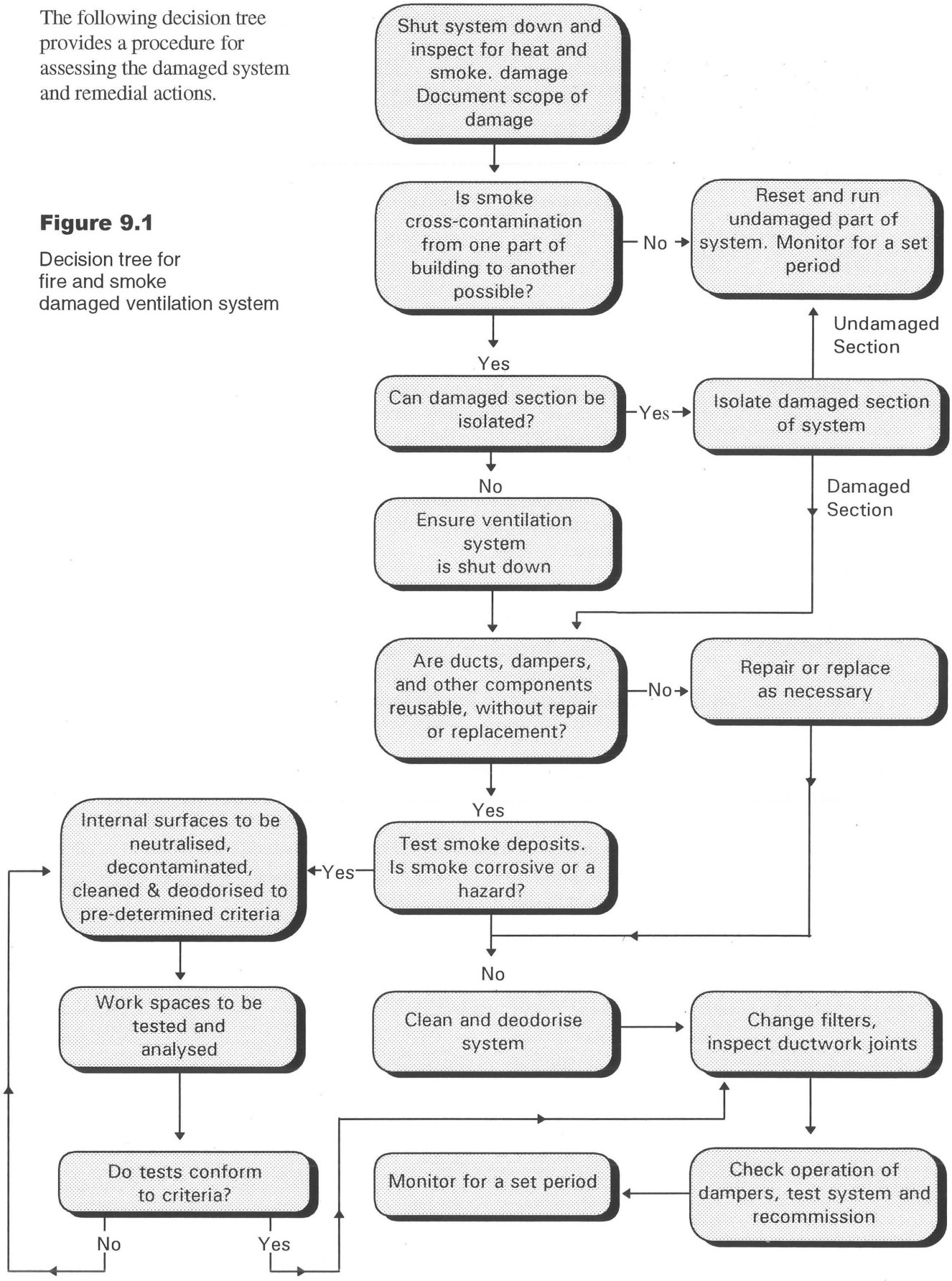
In certain circumstances it may be necessary to use an odour-masking chemical that produces a stronger more pleasant smell than the offending odour. This should only be used as a temporary measure and prior to the use of this method the chemical proposed should be subjected to a full COSHH assessment in relation to its proposed use to ensure that any associated health and safety risks are acceptable.

9 CLEANING AFTER FIRE AND SMOKE DAMAGE

The following decision tree provides a procedure for assessing the damaged system and remedial actions.

Figure 9.1

Decision tree for fire and smoke damaged ventilation system



10 HAZARDOUS MATERIALS

The *Control of Substances Hazardous to Health Regulations (COSHH)* [Ref 14] apply to substances that have been classified as being very toxic, toxic, harmful, corrosive or irritant. Biological agents are treated under this regulation as hazardous to health. All materials found during the cleaning process and materials used for cleaning are covered by these requirements.

The Regulations require that exposure (inhalation, ingestion or absorption through the skin) be prevented or adequately controlled.

The identification of substances that may be hazardous is complex and reference should be made to the following Health and Safety Executive publications:

- Health & Safety Commission *Approved Codes of Practice*
- *Control of Substances Hazardous to Health, Control of Carcinogenic Substances and Biological Agents:* ACOP L5 1995
- *Control of Asbestos at Work - Control of Asbestos at Work Regulations 1987*: ACOP L27 1993
- *Work with Asbestos Insulation, Asbestos Coating and Asbestos Insulating Board - Control of Asbestos at Work Regulations 1987*: ACOP L28 1993
- *Control of Lead at Work*: ACOP COP2 1985
- *Protection of Outside Workers Against Ionising Radiations*: ACOP L49 1993.

10.1 DANGEROUS OCCURRENCES

In some circumstances a substance or a combination of substances may present a risk of fire or explosion within the ventilation system.

Combustion may be a result of ignition due to heat or sparks.

10.2 LICENSED CONTRACTORS

Licensed contractors shall be employed where certain specific hazardous materials occur, eg asbestos (see also Section 11).

12.3 TYPICAL FAULTS

The following list comprises some commonly found faults which should be assessed by the Client as to their priority for remedial action:

- Damaged bird screens
- Leaking duct seams
- Over-lubricated bearings
- Presence of hazardous materials
- Damaged door seals
- Damaged coils/battery
- Loose bearings
- Faulty duct connections
- Damaged flexible ductwork and connectors
- Faulty control dampers
- Defective attenuating material and insulation
- Defective grilles
- Faulty fire dampers
- Broken turning vanes
- Blocked condensate drains
- Damaged sensors
- Corrosion damage
- Leaking filter frames.

12.4 CONTINGENCY

It is recommended that the Client specifies a contingency sum to be allowed for within the budget to ensure funds are available to effect remedial action in a cost effective manner. A schedule of rates for such work should be provided.

13 POST-CLEANING REPORT

It is important that a report is produced as part of a cleaning contract as this forms part of management control. The report should comprise the following:

13.1 DESCRIPTION OF SYSTEM

A brief overview of the building(s) and system(s) including type of plant, ducting, insulation and terminals

13.2 DESCRIPTION OF WORKS

A brief "Scope of Works" detailing the actual works carried out together with a statement of the cleaning method(s) used.

13.3 LOCATION OF ACCESS DOORS

The Client should provide all necessary drawings on which the Contractor shall show the location of all new access doors. Where drawings are not available the Contractor should be asked to identify in an agreed format where new doors have been installed.

13.4 REPORT ON THE SYSTEM

This report is intended to be a brief overview of the system and shall detail all those items found by the Contractor that may be detrimental to its safe operation. The following are examples of what may be included in a typical report:

Corrosion/finishes

Report on the deterioration of the sheet metal, insulation and paint finishes.

Hazardous materials

Advise the Clients of any hazardous materials that are found (see Section 10).

Condition of the equipment

General comments on the condition of the equipment including any faults found (see Section 12).

13.5 RESULTS OF THE CLEANING CONTRACT

This will include a comparison of the results of cleaning with the requirements of the "Scope of Works". If volume airflow measurements were taken before and after cleaning, comments on the differences (if any) should be included in this section. Note should also be made of the chemicals used in cleaning.

13.6 CERTIFICATE OF CLEANING

The Contractor should issue a certificate which should include:

- client and order number
- building
- location
- system
- date of completion
- level of cleanliness.

13.7 FINAL COMMENTS

The Contractor should make the following comments:

- recommendations for upgrading the filtration system(s), if appropriate
- recommended inspection periods
- recommended cleaning periods
- recommendations for a suitable records/log-book system.

13.8 APPENDICES

Attached to the post-cleaning report should be the following:

- certificate of cleaning
- volume airflow comparison charts, if called for by the contract
- copy of signed satisfaction/acceptance note(s). it shall be the responsibility of the Client to validate the quality of work
- Material Safety Data Sheets (MSDS) for chemicals used
- drawing(s) or other method(s) of recording the position of any additional access doors.

14 SYSTEM BALANCE AND REBALANCING AFTER CLEANING

System Balance refers to the system's ability to supply and extract the appropriate amounts of air to/from each module of a building in accordance with the design and the Client's wishes. This balancing is normally carried out at the time of commissioning the building and would be adjusted if there were major changes involving the following factors:

- the original design and use of the building
- the current usage of the building
- changes in use of the ventilation system
- deterioration of the ventilation system due to age and/or poor maintenance
- adjustments made by the occupier/tenant.

14.1 FACTORS AFFECTING SYSTEM BALANCE

The following are critical in ensuring that the ventilation system is balanced and stays in balance:

a) All fans must rotate in the right direction and at the correct speed. If a three phase motor is wired incorrectly it is possible for a fan to run backwards with much reduced volume airflow.

b) The correct volume airflow must be provided by fans.

c) All volume control dampers must be set correctly.

d) All fire dampers must be set in the open position and be fully operational.

e) Systems should be clean and free from obstructions.

Items a - e
These should have been checked and verified at the time of commissioning. It is quite likely that the volume airflow will have been adjusted over time by the occupants to reflect their choice of comfort.

f) All filters must be correctly installed and in the correct range of operating cleanliness. The pressure drop across the filter is normally used to indicate when filters should be changed.

g) Ductwork should be clean.

h) Air handling units (fan, coils and other components) should be clean.

Items f - h
Should be reviewed as part of the ongoing maintenance/monitoring regime.

i) The system should be free from blockage in the ductwork. A major cause of blockage is internal insulation/sound absorption material becoming unstuck and hanging down in the duct.

> **Item i**
> A blockage may occur anywhere in the ductwork and only comprehensive analysis and inspection is likely to find the problem. Low air volume in one sector of the system is usually an indicator of blocked ductwork, especially if all the dampers on that section are wide open.

Depending on the level of contamination within the system, cleaning can result in improved volume airflow. Measuring the volume airflow both before and after cleaning is sometimes specified as a method of demonstrating to the Client that there has, in fact, been a change in the volume airflow. This is a costly exercise and, if inspections are properly carried out before and after cleaning, it should not be necessary.

14.2 REBALANCING

Rebalancing after cleaning may be necessary where the building use or system layout has changed. Before any rebalancing is carried out, the system should be put back into operation and space conditions monitored. If the resulting conditions are acceptable then rebalancing may not be necessary.

Should rebalancing still be necessary then it is essential that the correct volume airflow be used. If the building and system has altered little from when it was built then the original schedule of volume airflow may be used. This is usually found in the *Owner's Operating Manual* on site. If this does not exist, or if there are changes to the building/system then it may be necessary to appoint a consultant to correctly size actual requirements.

Balancing a system is a skilled task and should be carried out by suitably qualified engineers/technicians following normal practice and the guidelines laid out in the CIBSE *"Commissioning Code for Air Distribution Systems"* [Ref 15] and the BSRIA Application Guide 3/89 *"The Commissioning of Air Systems in Buildings"* [Ref 16].

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BSRIA

The Building Services Research and Information Association
Old Bracknell Lane West, Bracknell, Berkshire RG12 7AH UK
Tel: +44 (0) 1344 426511 Fax: +44 (0) 1344 487575