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# The design, manufacture, installation and maintenance of flexible ductwork systems: a desk-based study


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# EXECUTIVE SUMMARY

The objective of this report is to provide a comprehensive overview of guidance relating to the design, manufacture, installation and maintenance of flexible ductwork in the built environment.

The report has been produced following extensive review of the following types of guidance.

- Statutory compliance through documents such as The Approved Documents of The Building Regulations
- Good practice through BS and BS EN standards
- Best practice through UK construction industry publications produced by organisations such as The Heating and Ventilating Contractors' Association (HVCA), The Chartered Institution of Building Services Engineers (CIBSE), The Building Services Research and Information Association (BSRIA) and The Association for Specialist Fire Protection (ASFP)
- Construction project requirements through mechanical specifications
- Best practice American guidance produced by The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), The Sheet Metal and Air Conditioning Contractors Association (SMACNA), The Air Diffusion Council (ADC) and The National Fire Protection Association (NFPA)
- Product standards through manufacturers' technical literature

In order to achieve statutory compliance and conform with best practice construction industry guidance, it is recommended that the design, manufacture, installation and maintenance of flexible ductwork should meet the following requirements.

### DIMENSIONS AND MECHANICAL REQUIREMENTS

Comply with BS EN 13180: 2002 Ventilation for buildings – Dimensions and mechanical requirements for flexible ductwork. This standard defines compliance criteria relating to nominal length, bending capability, operating pressure, crushing strength, air leakage, marking, labelling and packaging

### FIRE SAFETY IN THE DESIGN, MANAGEMENT AND USE OF BUILDINGS

Comply with BS 9999: 2008 Code of practice for fire safety in the design, management and use of buildings. This standard states that flexible ductwork connections should be constructed of:

- Non-combustible materials

or

- Materials conforming to Euroclass A1, as specified in BS EN 13501-1:2007 + A1:2009

or

- Material which, when tested in accordance with BS 476-6 has a fire propagation index I of not more than 12 and a sub-index $i_1$ of not more than 6, and is situated at least 1 metre from any fire damper

It also states that flexible ductwork connections should:

- Not exceed 3.7m in length
- Not pass through fire-resisting walls or floors or cavity barriers

## PRODUCT SELECTION

Comply with the recommendations of CIBSE Guide B3: 2002 – Ductwork, and HVCA DW/144 – Specification for sheet metal ductwork. These documents state that the following criteria shall be considered when selecting flexible ductwork

- Temperature range
- Fire rating
- Resistance to air flow
- Airtightness characteristics
- Length restrictions if applicable
- Support requirements
- Flexibility
- Insulation values
- System pressure

## INSTALLATION

Comply with the guidance given in CIBSE Guide B3: 2002 – Ductwork, HVCA DW/144 – Specification for sheet metal ductwork, Domestic ventilation compliance guide: 2010 Edition, MOD Specification 037 – Air conditioning, air cooling and mechanical ventilation in buildings, HTM 03-01: Specialised ventilation for healthcare premises and the requirements of leading construction project specifications.

- Flexible ductwork should only be used to make final connections to terminal units, grilles, diffusers and plenums
- The maximum length of flexible ductwork should be 1metre
- Flexible ducts should be pulled taught to ensure that the full internal diameter is obtained and flow resistance minimised. This is considered to have been achieved if the duct is extended to 90 per cent of its maximum length
- Flexible ducts shall be adequately supported to eliminate sagging and kinking – a maximum interval between supports of 600mm is recommended
- In no instances shall flexible duct connections be allowed on to fire dampers or through floors and walls
- The radius ratio R/D for bends shall be not less than 2, where R is the centre line radius and D is the diameter of the duct
- Flexible ducts should not be installed where they can be damaged, such as across loft areas where they may be stood on or have items placed on them, crushing the duct and restricting or preventing all air flow through the duct
- Connection of lengths of flexible duct must use a rigid connector and jubilee clips or similar to ensure a long-term seal is achieved. Connections of lengths of flexible duct should not be taped-only
- The integrity of flexible ductwork depends on the successful application of the correct sealant, gaskets or tape. The materials used should be suitable for the purpose intended and satisfy the specified pressure classification
- It is not practicable to make test holes or take test readings in metal or fabric flexible ducts. Where readings are required, the test holes should be made in rigid ductwork
- Where flexible ductwork is to be insulated, it should be factory applied

- The installation shall comply with the requirements of the Building Control Body and the Fire Officer
- Adequate and safe protection for all materials and products should be provided during transport to site and during storage on site

MAINTENANCE

Comply with the guidance given in BS EN 12097: 2006 Ventilation for buildings – Requirements for ductwork components to facilitate maintenance of ductwork systems, HVCA SFG 20 – Standard maintenance specification for building services, HVCA TR/19 – Internal cleanliness of ventilation systems and BSRIA FMS 1/97 – Standard specification for ventilation hygiene and CIBSE Guide B3: 2002 – Ductwork.

- A visual inspection of flexible ductwork should be undertaken for every 12 months to check damage, security of fittings, deterioration and internal condition
- Flexible ducts shall, where possible, be removed for inspection and cleaning, unless they can be satisfactorily cleaned in-situ. For cleaning of flexible ductwork in-situ, access shall be provided through rigid access components
- Cleaning methods must be adjusted to account for the type of flexible duct

# CONTENTS

# 1 INTRODUCTION

There is a lack of clarity over standards applicable to flexible ductwork. This has given rise to a wide variety of interpretations by those parties involved in the design specification, manufacture, installation and maintenance of ventilation and air conditioning systems containing flexible ductwork.

This report has been produced in response to a request from ADCAS for a desk-based study into the legislation, product standards, and design, installation and maintenance guidance related to flexible ductwork.

The purpose of the report is to provide a body of information, from which an ADCAS publication about flexible ductwork could be produced in 2012.

# 2 STATUTORY COMPLIANCE

This aim of this chapter is to examine the statutory compliance requirements for flexible ductwork. The principal points of reference are the Approved Documents of the Building Regulations.

The Approved Documents have been approved and issued by the Secretary of State for the purpose of providing practical guidance with respect to the requirements of Schedule 1 to and Regulation 7 of the Building Regulations 2000 (SI 2000/2531) for England and Wales.

The intention of issuing Approved Documents is to provide guidance about compliance with specific aspects of Building Regulations in some of the more common building situations. They set out what in ordinary circumstances, may be accepted as reasonable provision for compliance with the relevant requirement(s) of building regulations to which they refer

It is important to remember that if you are the person (eg designer, builder installer) carrying out building work to which any requirement of Building Regulations applies you have responsibility to ensure that the work complies with any such requirement. The building owner may also have a responsibility for ensuring compliance with building regulation requirements and could be served with an enforcement notice in cases of non-compliance.

## 2.1 APPROVED DOCUMENT, MATERIALS AND WORKMANSHIP - TO SUPPORT REGULATION 7 OF THE BUILDING REGULATIONS

### 2.1.1 Overview of Approved Document – Materials and workmanship

This standard has been prepared to ensure that all building work shall be carried out with adequate and proper materials which:

- Are appropriate for the circumstances in which they are used
- Are adequately mixed or prepared
- Are applied, used or fixed so as adequately to perform the functions for which they are designed, and in a workmanlike manner.

### 2.1.2 Materials and workmanship

This document states that the requirements of regulation 7 of the Building Regulations will be met where materials[1] are:

- Of a suitable nature and quality in relation to the purposes and conditions of their use

And the workmanship is such that

- Where relevant, materials are adequately mixed or prepared; and
- Applied, used or fixed so as to perform adequately the functions for which they are intended

[1] Materials include products, components, fittings, naturally occurring materials, eg stone, timber and thatch, items of equipment and backfilling for ev acuations in connection with building work

### 2.1.3 Ways of establishing the fitness of materials

The document states that there are a number of ways in which the suitability of a material for use for a specific purpose may be assessed. It proposes the following are aids which may be used for establishing this.

#### *2.1.3.1 British Standards*

The material conforms to the relevant provisions of an appropriate British Standard.

#### *2.1.3.2 Other national and international specifications*

The material conforms to the national technical specifications of other Member States which are contracting parties to the European Economic Area, as long as such specifications provide in use at least an equivalent level of performance to the relevant British Standard. Where necessary, it is up to the person intending to carry out the work to provide translations and to demonstrate equivalence.

#### *2.1.3.3 Technical approvals*

The material is covered by a national or European certificate issued by a European Technical Approvals issuing body, and the conditions of use are in accordance with the terms of the certificate. Where necessary it is up to the person intending to carry out the work to provide translations and to demonstrate equivalence.

#### *2.1.3.4 CE marking*

The material has CE marking. The CE marking gives a presumption of conformity with the stated minimum legal requirements when placed on the market as set out in the Construction Products Regulations 1991[2].

In this context relevant requirements are defined in relation to the essential requirements of the Construction Products Directive, and are

- Mechanical resistance and stability
- Safety in case of fire
- Hygiene, health and the environment
- Safety in use
- Protection against noise
- Energy economy and heat retention

#### *2.1.3.5 Independent certification schemes*

There are many UK product certification schemes. Such schemes certify compliance with the requirements of a recognised document which is appropriate to the purpose for which the material is to be used.

[2] Note the Construction Products Directive was repealed by Regulation (EU) No 305/2011 in March 2011. However, the essential requirements remain the same

#### *2.1.3.6 Tests and calculations*

It can be shown by tests, by calculation or by other means that the material will be capable of performing the function for which it is intended.

#### *2.1.3.7 Past experience*

The material can be shown by experience, such as in a building in use, to be capable of performing the function for which it is intended.

#### *2.1.3.8 Sampling*

Local authorities have the power to take samples of materials to be used in building work. Regulation 17 allows the local authority (but not approved inspectors) to take such samples as they consider necessary to establish compliance with the provisions of the Regulations.

### 2.1.4 Ways of establishing the adequacy of workmanship

The document states that it may be useful to consider the following aids for establishing the adequacy of workmanship.

#### *2.1.4.1 Standards*

The method of carrying out the work is included in the recommendations of a British Standard Code of Practice, or the method conforms to an equivalent technical specification which may include a national technical specification of other Member States which are contracting parties to the European Economic Area.

#### *2.1.4.2 Technical approvals*

The workmanship is specified for a material covered by a national or European certificate issued by a European certificate issued by a European Technical Approvals issuing body, and the conditions of use are in accordance with the terms of the certificate.

#### *2.1.4.3 Past experience*

It can be shown by experience, such as in a building in use, that the method of workmanship is capable of performing the function for which it is intended.

## 2.2 APPROVED DOCUMENT B VOLUME 2 – FIRE SAFETY – BUILDINGS OTHER THAN DWELLINGS

### 2.2.1 Overview of Approved Document B volume 2

Approved Document B volume 2 deals with different aspects of fire safety. It has the following aims:

- To ensure satisfactory provision of means of giving an alarm of fire and a satisfactory standard of means of escape for persons in the event of a fire in a building
- To ensure that fire spread over the internal linings of a building is inhibited
- To ensure the stability of buildings in the evnt of a fire
- To ensure that there is a sufficient degree of fire separation within buildings and to inhibit the unseen spread of smoke in concealed spaces in buildings

### 2.2.2 Materials and workmanship

The document states that any building work which is subject to the requirements imposed by Schedule 1 of the Building Regulations should, in accordance with Regulation 7, be carried out with proper materials and in a workmanlike manner.

Compliance with Regulation 7 can be shown in a number of ways. These include appropriate use of a product bearing CE marking, a product complying with an appropriate technical specification, a British Standard or an alternative national technical specification of a Member State of the European Union. Compliance can also be achieved by a product covered by a national or European certificate issued by a European Technical Approval Issuing body, where the conditions of use are in accordance with the terms of the certificate.

### 2.2.3 Mechanical ventilation and air conditioning systems

The document states that any system of mechanical ventilation should be designed to ensure that, in a fire, the ductwork does not assist in transferring fire and smoke through the building and put at risk the protected means of escape from the accommodation areas. Any exhaust points should be sited so as not to further jeopardize the building, i.e away from final exits, combustible building cladding or roofing materials and openings into the building.

The document states that further guidance on the design and installation of mechanical ventilation and air conditioning plant is given in BS 5720:1979[3]. It also states that guidance on the use of ventilation in a place of assembly can be found in BS 5588-6: 1991[4]

### 2.2.4 Ventilation ducts, flues etc

The document states that where air handling ducts pass through fire separating elements the integrity of those elements should be maintained by one of three basic methods:

- Method 1 Protection using fire dampers
- Method 2 Protection using fire-resisting enclosures

[3] This British Standard has been withdrawn.

[4] Note that BS5588 has been superseded by BS 9999: 2008

- Method 3 Protection using fire-resisting ductwork

The specific provisions of test for fire resistance of ductwork is shown below

| Part of building | Minium provisions when tested to the relev ant parts of BS 476 -24 (minutes) | | | Minium provisions when tested to the relv ant European standard (minutes)[5] | Method of exposure |
|---|---|---|---|---|---|
| | Loadbearing capacity | Integrity | Insulation | | |
| Duct | Not applicable | 30 | No provision | E 30 | From outside |

2.2.5 Internal fire spread (linings)

The document states that to inhibit the spread of fire within the building, the internal linings shall:

- Adequately resist the spread of flame over their surfaces;

and

- Have, if ignited, a rate of heat release or a rate of fire growth, which is reasonable in the circumstances

The document states that the requirements for internal fire spread will be met if the spread of flame over the internal linings of the building is restricted by making provision for them to have low rates of surface spread of flame and, in some cases, to have a low rate of heat release, so as to limit the contribution that the fabric of the building makes to fire growth.

To restrict the use of materials which ignite easily, which have a high rate of heat release and/or which reduce the time to flashover, maximum acceptable 'fire propagation' indices are specified, where the National test methods are being followed. These are determined by reference to the method specified in BS 476-6:1981 or 1989 *Method of test for fire propagation of products.* Index of performance (1) relates to the overall test performance, whereas sub-index (i1) is derived from the first three minutes of test.

[5] National classifications do not automatically equate with the equivalent classifications in the European column. Products cannot therefore typically assume a European class unless they have been tested accordingly

## 2.3 APPROVED DOCUMENT F – VENTILATION 2010 EDITION

### 2.3.1 Overview of Approved Document F

This document has been approved by the Secretary of State to provide practical guidance on ways of complying with the requirements in Building Regulations, in so far as it relates to fixed systems for mechanical ventilation.

### 2.3.2 Materials and workmanship

The document states that any building work which is subject to the requirements imposed by the Building Regulations should in accordance with regulation 7, be carried out with proper materials and in a workmanlike manner.

Compliance with regulation 7 can be achieved in a number of ways. These include demonstrating the appropriate use of:

- A product bearing the CE marking
- A product complying with an appropriate technical specification, a British Standard, or an alternative national technical specification of a Member of State of the European Union that provides an equivalent level of safety and protection
- A product covered by a national or European certificate issued by a European Technical Approval issuing body, provided the conditions of use are in accordance with the terms of the certificate.

### 2.3.3 Installation of ventilation systems

The document recommends that ventilation systems are installed in new and existing dwellings in accordance with the guidance in the 2010 edition of the Domestic Ventilation Compliance Guide. It states that section 5 of the Domestic Ventilation Compliance Guide includes an installation checklist which should be completed by the system installer.

In Section 8 of Approved document F, references are provided to other ventilation guidance including CIBSE Guide B: Heating, ventilating, air conditioning and refrigeration, HVCA DW/143: A practical guide to air leakage testing, HVCA DW/144: Specification for sheet metal ductwork, HVCA TR/19: Internal cleanliness of ventilation systems and HTM 03: Ventilation healthcare premises

### 2.3.4 Air flowrate testing and commissioning of ventilation systems

The regulations require:

- Mechanical ventilation systems to be commissioned (where they can be tested and adjusted to provide adequate ventilation and a commissioning notice to be given to the Building Control Body (BCB)
- Air flowrates for mechanical ventilation systems in new dwellings to be measured and a notice given to the BCB

## 2.4 DOMESTIC VENTILATION COMPLIANCE GUIDE, 2010 EDITION

### 2.4.1 Overview of the domestic ventilation compliance guide

This guide provides detailed guidance to help persons comply with requirements in Building Regulations for installation, inspection, testing, commissioning and provision of information when installing fixed ventilation systems in new and existing dwellings.

The aim is to ensure the provision of adequate ventilation while minimising energy use and environmental problems such as noise and thermal discomfort.

### 2.4.2 Installation of ducts - flexible

The document states that ducts should not be installed where they can be damaged, for example across loft areas where they may be stood on or have items placed on them, crushing the duct and restricting or preventing all air flow through the duct.

Flexible duct should be pulled taught to ensure that the full internal diameter is obtained and flow resistance minimised. This is considered to have been achieved if the duct is extended to 90 per cent of its maximum length.

Flexible ductwork should be supported as suitable intervals to minimise sagging. Ensure flexible ducting is installed without peaks or troughs.

Bends in flexible duct should have minimum inside radius equal to the diameter of the duct – See Diagram 1 on the following page. If tighter bends are required, rigid bends should be used.

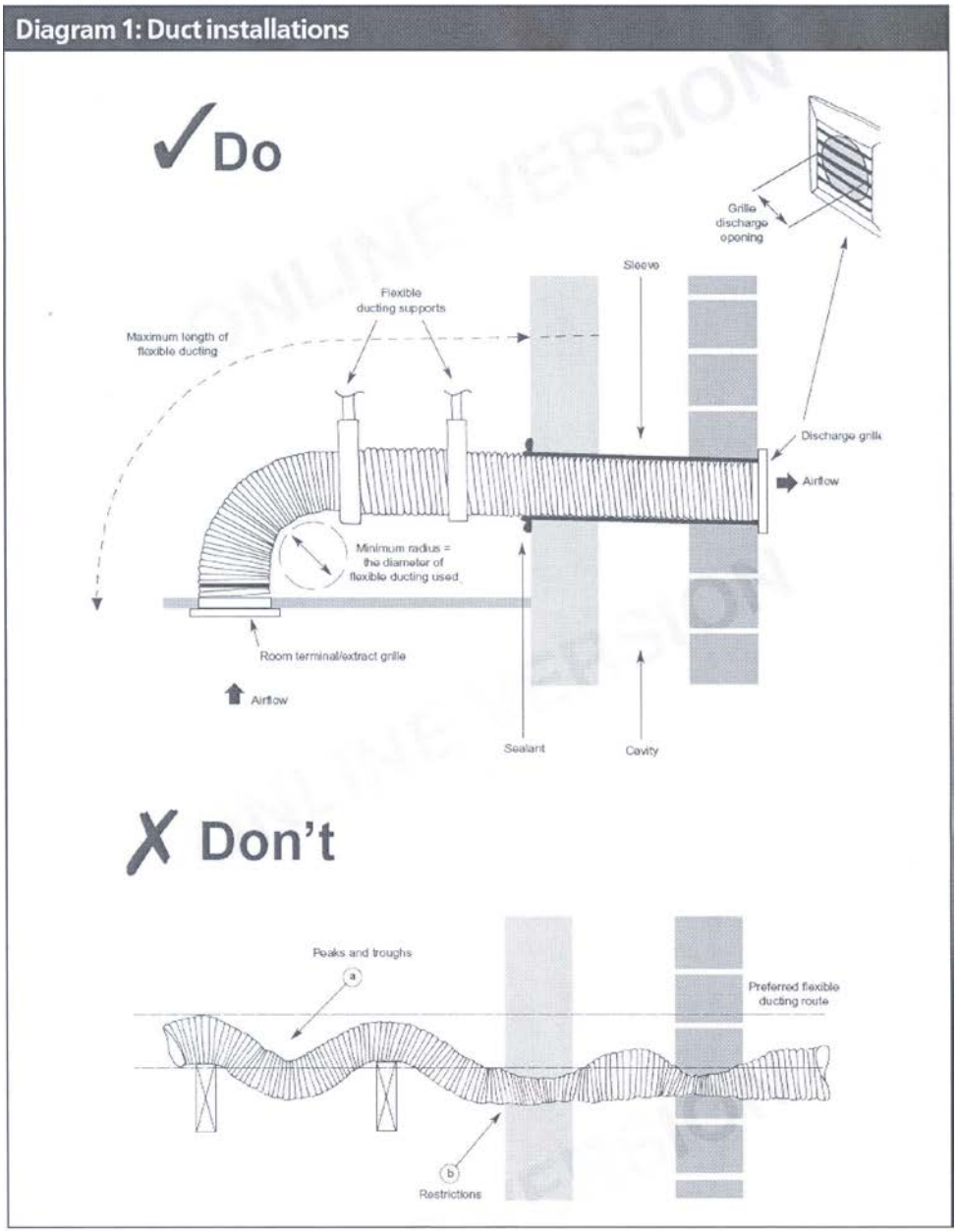
It is suggested that flexible ducts should be supported at intervals not exceeding 600mm.

### 2.4.3 Duct connections

The guide states that all duct connections require sealing. Where ducts are installed against a solid structure this can be difficult to achieve. In such locations preassembly of duct sections should be considered. This will require that connections are permanent to ensure the seal is maintained during installation.

Where access to ducts will not be possible after construction is complete, i.e. within floor and wall voids, consideration should be given to permanent connection and sealing with an a appropriate non-hardening sealant, and not using duct tape to achieve connection and sealing.

Connection of lengths of flexible duct must use a rigid connector and jubilee clips or similar to ensure a long term seal is achieved. Connections of lengths of flexible duct should not be taped-only




## 2.5 APPROVED CODE OF PRACTICE AND GUIDANCE TO THE WORKPLACE (HEALTH, SAFETY AND WELFARE) REGULATIONS

### 2.5.1 Overview of ACOP to the Workplace (Health, Safety and Welfare) Regulations

This document explains the requirements, under the Workplace (Health, Safety and Welfare) Regulations 1992, which dutyholders should follow to ensure appropriate working conditions are provided for employees.

### 2.5.2 Mechanical ventilation systems

The document states that mechanical ventilation systems, including air conditioning systems, should be regularly and properly cleaned, tested and maintained to ensure they are kept free of anything which may contaminate the air.

## 2.6 NON-DOMESTIC BUILDING SERVICES COMPLIANCE GUIDE, 2010 EDITION

### 2.6.1 Overview of the non-domestic building services compliance guide

This guide provides detailed guidance for persons installing fixed building services in new and existing non-domestic buildings to help them comply with Building Regulations. It covers work on new and existing systems.

### 2.6.2 Air distribution systems in new and existing buildings

The guide states that in order to limit air leakage, ventilation ductwork should be made and assembled so as to be reasonably airtight. It adds that ways of meeting this requirement would be to comply with the specifications given in HVCA DW/1444 – Specification for sheet metal ductwork

It also states that membership of the HVCA and ADCAS is one way of demonstrating suitable qualifications

# 3 BS AND BS EN STANDARDS

BS and BS EN standards are published documents that contain a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition. Their aim is to increase the reliability and the effectiveness of goods and services we use.

BS and EN Standards are designed for voluntary use and do not impose any regulations. However, laws and regulations may refer to certain standards and make compliance with them compulsory.

The aim of this chapter is to examine the BS and BS EN standards related to flexible ductwork.

## 3.1 BS EN 13180: 2002 VENTILATION FOR BUILDINGS – DUCTWORK – DIMENSIONS AND MECHANICAL REQUIREMENTS FOR FLEXIBLE DUCTWORK

### 3.1.1 Overview of BE EN 13180:2002

This standard has been prepared to:

- Specify dimensions and tolerances for flexible ducts
- Give methods for the performance testing of flexible ducts
- Enable assessment of minimum technical requirements

The standard identifies the following parameters which shall be tested or inspected:

- Dimensions and tolerances
- Mechanical resistance

The standard defines a flexible duct in the following manner:

*"Duct which can be manually longitudinally compressed or decompressed and flexed without permanently damaging the cross section area"*

### 3.1.2 Dimensions for flexible ducts

The standard states that the nominal diameter of flexible ducts and fittings shall comply with the following criteria.

| Nominal diameter (mm) | Deviations (mm) | |
|---|---|---|
| | Class A | Class B |
| **63** | | |
| **80** | +1 | +3 |
| **100** | 0 | 0 |
| **125** | | |
| 150 | | |
| **160** | | |
| **200** | +2 | +4 |
| **250** | 0 | 0 |
| 300 | | |
| **315** | | |
| 355 | | |
| **400** | | |
| 450 | +3 | +6 |
| **500** | 0 | 0 |
| 560 | | |
| **630** | | |

Note: Figures in bold indicate recommended sizes in accordance with EN 1506

### 3.1.3 Mechanical properties and requirements of flexible ducts

#### *3.1.3.1 Nominal length*

This standard states that after decompression, the measured length shall not be more than 3% shorter than the manufacturer's quoted nominal length.

#### *3.1.3.2 Bending capability*

This standard states that the sample shall be bent by hand three times, at its nominal diameter or at the bending radius quoted by the manufacturer, whichever is smaller. The initial height of the duct shall not reduce or expand by more than 20% at the centre line of the test former at any time during the test.

#### *3.1.3.3 Pressure*

This standard states that flexible ducts shall be capable of withstanding 2.5 times the manufacturer's quoted positive pressure and negative rated pressure when tested in accordance with the test method desctribed in the standard.

#### *3.1.3.4 Crushing strength*

This standard states that flexible ducts delivered in compressed form shall remain undamaged and shall resist loads perpindicular to their axis.

It states that an uncompressed duct can be subject to a load perpendicualr to its axis and that the crushing strength property to assess the mechanical resistance shall be specified according to the application.

#### *3.1.3.5 Air leakage*

The standard states that when tested in accordance with the test method desctribed in the standard, the maximum air leakage factor should be as follows:

| Air tightness class | Maximum air leakage factor l/s per m$^2$ |
|---|---|
| A | $0.027 \times p_s^{0.65}$ |
| B | $0.009 \times p_s^{0.65}$ |
| C | $0.003 \times p_s^{0.65}$ |

### 3.1.1 Marking, labelling and packaging

This standard states that the marking of the product or product packaging shall contain at leasts the nominal diameter and the nominal length of the duct.

## 3.2 BS 9999: 2008 CODE OF PRACTICE FOR FIRE SAFETY IN THE DESIGN, MANAGEMENT AND USE OF BUILDINGS

### 3.2.1 Overview of BE 9999:2008

As a code of practice, this British Standard takes the form of guidance and recommendations. This standard has designed as a co-ordinated package covering the four main areas that influence fire safety measures, namely:

- Fire safety management
- The provision of means of escape
- The structural protection of escape facilities and the structural stability of the building in the event of a fire
- The provision of access and facilities for fire-fighting

The standard supersedes the BS 5588 series of standards[6].

### 3.2.2 The design stage

The standard states that it is important that:

- The material specified is appropriate for its end use
- The material or product specified has appropriate field of application reports showing it to be fit for the intended application. Test reports are inadequate for this purpose
- The correct construction or installation of the material or product is described and not compromised by inadequate knowledge of the contractor or sub-contractors
- All systems can be adequately commissioned and tested

### 3.2.3 Mechanical ventilation and air conditioning systems

The standard states that any system of mechanical ventilation should be designed to ensure that in a fire the air movement in the building is directed away from protected escape routes and exits, or that the system (or an appropriate section of it) is closed down.

It also states that when ductwork systems are installed within a building it is important that the ductwork does not assist in transferring fire and smoke through the building and put at risk the protected means of escape from the accommodation areas.

### 3.2.4 Flexible ductwork joints and connections

The standard states that flexible ductwork connections should:

- Not exceed 3.7m in length
- Not pass through fire-resisting walls or floors or cavity barriers

[6] BS5588-9: 1999 Fire precautions in the design, construction and use of buildings. Part 9 is entitled Code of practice for ventilation and air conditioning of ductwork

It also states that flexible ductwork connections should be constructed of:

- Non-combustible materials[7]

or

- Materials conforming to Euroclass A1, as specified in BS EN 13501-1:2007 + A1:2009

or

- Material which, when tested in accordance with BS 476-6 has a fire propagation index I of not more than 12 and a sub-index $i_1$ of not more than 6, and is situated at least 1 metre from any fire damper

## 3.3 BS EN 15423: 2008 VENTILATION FOR BUILDINGS – FIRE PRECAUTIONS FOR AIR DISTRIBUTION SYSTEMS IN BUILDINGS

### 3.3.1 Overview of BS EN 15423:2008

This document applies to all air distribution systems. It gives guidance for system designers, installers, commissioners and maintenance teams on the incorporation of protective measures for air distribution systems, to prevent the initiation and spread of fire, smoke and other by-products of combustion.

### 3.3.2 General requirements

This standard states that components in the air distribution system shall be made or installed in such a way that they will not increase the hazard of spreading fire and smoke gases in the case of fire.

It also states that the materials used in buildings, air distribution systems and their components shall not contribute to the development of fire in accordance with any local requirement.

### 3.3.3 Flexible duct component requirements

This standard states that materials for walls in ventilation ducts shall be selected so that the ducts can withstand the functions they are exposed to such as heat and cleaning.

It also states that flexible ducts should comply with the following requirements.

- Fire resistance: BS EN 13501-1, BS EN 13501-3
- Fire reaction: No requirement
- Mechanical strength: BS EN 13180
- Precaution for installation: BS EN 12097
- Air tightness: BS EN 13180
- Maintenance, including cleaning: BS EN 12097

[7] Approved Document B (Fire Safety) defines a non-combustible material as any material which when tested to BS 476-11 does not flame nor cause any rise in temperature on either the centre (specimen) or furnace thermocouples, or any product classified as non-combustible under BS 476-4

## 3.4 BS EN 13501-1: 2007 +A1: 2009 FIRE CLASSIFICATION OF CONSTRUCTION PRODUCTS AND BUILDING ELEMENTS

### 3.4.1 Overview of BS EN 13501-1: 2007 + A1: 2009

This standard provides the reaction to fire classification procedure for all construction products, including products incorporated within building elements. Products are considered in relation to their end-use applications.

### 3.4.2 Performance classification

This standard states that any homogenous product applying for class A1[8] shall be tested in accordance with EN ISO 1182 and EN ISO 1716. Each substantial component of ant non- homogenous product applying for class A1 shall be tested in accordance with EN ISO 1182 and EN ISO 1716.

A product classified as A1 shall satisfy the following criteria:

- Gross calorific potential (PCS) ≤ 2.0 MJ/kg
- Temperature rise (ΔT) 30°C
- Mass loss (Δm) ≤ 50%
- Duration of sustained flaming[9] ($t_f$) = 0s

## 3.5 BS EN 12097: 2006 VENTILATION FOR BUILDINGS – REQUIREMENTS FOR DUCTWORK COMPONENTS TO FACILITATE MAINTENANCE OF DUCTWORK SYSTEMS

### 3.5.1 Overview of BS EN 12097:2006

This standard specifies requirements for dimensions, shape and location for access panels for cleaning and service in ductwork systems.

### 3.5.2 Openings for flexible circular ducts

This standard states that flexible ducts shall, where possible, be removed for inspection and cleaning, unless they can be satisfactorily cleaned in-situ. For cleaning of flexible ductwork in-situ, access shall be provided through rigid access components.

[8] A flexible duct constructed from materials conforming to Euroclass A1 will comply with the requirements of BS 9999: 2009 Code of practice for fire safety in the design, management and use of buildings

[9] Sustained flaming is defined as the existence on or over the surface for a minimum period of time

## 3.6 BS 476-6: 1989 +A1: 2009 FIRE TESTS ON BUILDING MATERIALS AND STRUCTURES

### 3.6.1 Overview of BS 476-6:1989 + A1: 2009

This part of BS 476 specifies a method of test, the result being a fire propagation index, that provides a comparative measure of the contribution to the growth of a fire made by an essentially flat material or assembly. It is primarily intended for the assessment of the performance of internal wall and ceiling linings.

A specimen of the product is subjected to a specific heating regime. The test takes into account the combined effect of factors such as the ignition characteristics, the amount and rate of heat release and the thermal properties of the product in relation to their ability to accelerate the rate of fire growth.

### 3.6.2 Performance classification

The determination of the fire propagation index requires the results from three specimens, each producing valid test results.

The test result is expressed in terms of a fire propagation index (I) that is the summation of three time-based sub-indices ($I = i_1 = i_2 + i_3$). The higher the fire propagation index, the greater is the influence of the product on accelerating the growth of a fire. [10]

[10] A flexible duct constructed from materials which, when tested in accordance with BS 476-6 has a fire propagation index I of nor more than 12 and a sub-index $i_1$ of not more than 6 will comply with the requirements of BS 9999: 2009 Code of practice for fire safety in the design, management and use of buildings

## 3.7 BS 476-7: 1997 FIRE TESTS ON BUILDING MATERIALS AND STRUCTURES

### 3.7.1 Overview of BS 476-7:1997

This part of BS 476 specifies a method of test for measuring the lateral spread of flame along the surface of a specimen of a product.

It provides data suitable for comparing the end-use performances of essentially flat materials, composites or assemblies, which are used primarily as the exposed surfaces of walls and ceilings.

A minimum of six and a maximum of nine specimens are subjected to a specific heating and ignition regime. The test takes into account the combined effect of factors such as the ignition characteristics and extent to which the flame spreads over the surface of the products under opposed flow conditions. The influence of any underlying materials on these factors, in relation to their ability to influence the rate of fire growth, is also taken into account.

### 3.7.2 Performance classification

The test result is a function of the distance, and rate of, the lateral spread of flame. This is classified according to performance classes 1 to 4. The following table summarises the classification of spread of flame.

| Classification | Spread of flame at 1.5 minutes | | Final spread of flame | |
|---|---|---|---|---|
| | Limit (mm) | Limit for one specimen in the sample(mm) | Limit (mm) | Limit for one specimen in the sample(mm) |
| Class 1 | 165 | 165 + 25 | 165 | 165 + 25 |
| Class 2 | 215 | 215 + 25 | 455 | 455 + 45 |
| Class 3 | 265 | 265 + 25 | 710 | 710 + 75 |
| Class 4 | Exceeding the limits for Class 3 | | | |

# 4 CONSTRUCTION INDUSTRY GUIDANCE DOCUMENTS

A wide variety of construction industry guidance is produced by organisation such as The Heating and Ventilating Contractors' Association (HVCA), The Chartered Institution of Building Services Engineers (CIBSE), The Building Services Research and Information Association (BSRIA) and The Association for Specialist Fire Protection (ASFP).

These documents are designed for voluntary use and do not impose any regulations. However, laws and regulations may refer to certain standards as ways of complying with specific requirements.

The aim of this chapter is to examine the construction industry guidance related to flexible ductwork.

## 4.1 HVCA DW/144 – SPECIFICATION FOR SHEET METAL DUCTWORK

### 4.1.1 Overview of DW/144

This specification sets out the minimum requirements for the manufacture and installation of ductwork for commericail and industrial air distribution systems made from zinc-coated steel, mild steel, stainless steel, pre-coated steel, and aluminium.

### 4.1.2 Cautionary note to all ductwork designers and manufacturers

The document states that ductwork constructed to DW/144 Standard has no tested fire resistance. General purpose ventilation/air conditioning ductwork and its ancillary items do not have a fire rating and cannot be either utilised as or converted into a fire rated ductwork system unless the construction materials of the whole system including supports and penetration seals are proven by test and assessment in accordance with BS 476 Part 24.

### 4.1.3 Ductwork systems and fire hazards

The document states that fire and smoke containment/hazards are factors which influence the design and installation of ductwork systems. It states that information concerning fire protection systems is laid down in BS 5588[11] and that there are the following three methods of fire protection, related to ductwork systems, as given in BS 5588 Part 9 (1989):

- Method 1 Protection using fire dampers
- Method 2 Protection using fire-resisting enclosures
- Method 3 Protection using fire-resisting ductwork

### 4.1.4 Flexible ducts - general

The document states that flexible duct connections shall be used in the following applications:-

- Terminal units
- Fan coil units
- Constant Volume/Variable Air Volume units
- Grilles and Diffusers

[11] Note that BS5588 has been superseded by BS 9999: 2008.

- Plenum boxes
- Distribution ducts between the above items.

They are available in a range of materials including metal, P.V.C, fabric and with or without thermal insulation.

The document states that the designer/contractor shall consider the following when selecting a particular type of flexible duct including:

- Temperature range
- Fire rating
- Resistance to air flow
- Airtightness characteristics
- Length restrictions if applicable
- Support requirements
- Flexibility
- Insulation values
- System pressure

### 4.1.5 Flexible ducts - metal

The document states that flexible ducts made of coated steel, stainless steel or aluminium are normally helically wound with a lock seam to form a corrugated duct capable of being bent without deforming the circular section. Bending is done by closing the corrugations in the throat and slightly opening the corrugations at the back of the bend. Some re-adjustment is possible but small radius bends cannot be straightened without leaving some distortion of the corrugations. Repeated bending is not recommended.

The ducts shall be mechanically fastened at each end and particular care shall be taken to ensure that the required airtightness of the system is maintained.

Fastenings and sealing should be as for rigid circular ducts, as described later in this section of the report.

### 4.1.6 Flexible ducts - fabric

The document states that flexible ducts made from materials including P.V.C/polyester laminate, aluminium/polyester laminate encapsulating high tensile steel wire helix are a very flexible form of construction. The length of flexible duct used should therefore be kept to a minimum, consistent with the particular application.

Flexible ducts shall be fastened at each end using a proprietary band. Care should be taken not to damage the flexible duct and to ensure that the required airtightness of the system is maintained.

### 4.1.7 Flexible ducts - supports

The document states that Flexible ducts have a higher resistance factor than conventional ductwork and should be supported in such a way that excessive sagging and consequently

### 4.1.8 Flexible ducts – test holes

The document states that it is not practicable to make test holes or take test readings in metal or fabric flexible ducts. Where readings are required, the test holes should be made in rigid ductwork.

### 4.1.9 Joint sealing and sealants

The document states that the integrity of the ductwork depends on the successful application of the correct sealant, gaskets or tape. The materials used should be suitable for the purpose intended and satisfy the specified pressure classification.

In all cases, sealant materials must be applied strictly in accordance with the manufacturer's instructions and COSHH assessment

### 4.1.10 Fastenings

#### *4.1.10.1 Permitted types and maximum centres*

The following table sets out the permitted fastenings and maximum spacings for low, medium and high- pressure circular ducts. All duct penetrations shall be sealed.

| Type of Fastening | Sheet to sheet | | Sheet to section (jointing flanges and intermediate stiffeners) | |
|---|---|---|---|---|
| | Lap joints | Cross joints | Spirally wound | Straight seamed |
| 1 | 2 | 3* | 4* | 5* |
| | mm | mm | mm | mm |
| Mechanically | 60 | 150 | 150 | 150 |
| Self-piercing screws | 60 | 150 | 150 | 150 |
| Set screws and nuts | - | - | 300 | 300 |
| Lock bolts | 60 | - | 300 | 300 |
| Spot welds | 30 | 30 | 150 | 150 |

*Minimum of three fixings

#### *4.1.10.2 Rivets*

Manufacturers' recommendations as to use, size and drill size are to be followed. Rivets resulting in an unsealed aperture shall not be used.

#### *4.1.10.3 Set screws, nuts and lock bolts*

Materials shall be of mild steel, protected by electro-galvanizing, sherardizing, zinc plating or other equal and approved finish.

#### *4.1.10.4 Self-tapping and piercing screws*

Providing an adequate seal can be achieved, and the protrusions into the ductwork are unlikely to cause injury, then self-tapping or piercing screws may be sued.

## 4.2 CIBSE GUIDE B3 – DUCTWORK

### 4.2.1 Overview of CIBSE Guide B3

This aim of this document is to provide information on current practice in the design and installation of ventilation and air conditioning systems.

### 4.2.2 Classification of ductwork systems

This document classifies ductwork systems in the following manner.

| Classification of ductwork systems | Air leakage limit* | Maximum design static pressure (pa) | Comments |
|---|---|---|---|
| Low pressure system (Class A) | 6% | 500 +ve<br>500 -ve | *0.027 x $p^{0.65}$ l/s per m² of duct area where $p$ is the static gauge pressure in the duct |
| Medium pressure system (Class B) | 3% | 1000 +ve<br>750 -ve | *0.009 x $p^{0.65}$ l/s per m² of duct area where $p$ is the static gauge pressure in the duct |
| High pressure system (Class C) | 2% | 2000 +ve<br>750 -ve | *0.003 x $p^{0.65}$ l/s per m² of duct area where $p$ is the static gauge pressure in the duct |

### 4.2.3 Spatial requirements

The document states that provision of sufficient space for ductwork is essential and must be addressed at an early stage in the design process of a building. Adequate space must be allowed around ducts for fitting of insulation, hangers and supports during installation and for access during subsequent maintenance.

### 4.2.4 Fan power energy requirements

The document states that energy can be reduced in ventilation systems by minimising the length of flexible ducting

### 4.2.5 Methods of fire protection of ductwork

The document states that there are three methods of fire protection related to ductwork systems, as given in BS 5588: Part 9[12] . These three methods are as follows.

- Method 1: Protection using fire dampers;
- Method 2: Protection using fire resisting enclosures;
- Method 3: Protection using fire resisting ductwork

### 4.2.6 Fire resistance and DW/144

The document states that ductwork constructed to HVCA specification DW/144 has no tested fire resistance. General purpose ventilation/air conditioning ductwork and its ancillary items do not have a fire rating and cannot be either utilised in, or converted into, a fire rated ductwork system unless the construction materials of the whole system (including supports and penetration seals) are proven by test and assessment in accordance with BS 476: Part 24

[12] Note that BS5588 has been superseded by BS 9999: 2008

### 4.2.7 Fire rating

The document states that where ductwork is required to be fire rated, it is specified according to stability, integrity and insulation.

Stability is the ability of a duct to stay in place for the specified period of time when exposed to a fire. Integrity is the ability of the duct to prevent the passage of fire either into or out of the duct. Insulation is usually called for if the Building Control Officer believes that a duct carrying hot smoke may become sufficiently hot to compromise an escape route.

### 4.2.8 Flexible ducts

The document states that flexible duct connections shall be used in the following applications:-

- Terminal units
- Fan coil units
- Constant Volume/Variable Air Volume units
- Grilles and Diffusers
- Plenum boxes
- Distribution ducts between the above items.

It adds that flexible ducts can be abused to overcome poor installation, such as where ducts do not line up. This can result in poor airflow at the grille and/or excessive noise. The following advice should be noted when using flexible ductwork (particularly metal types)

- Lengths should be as short as possible
- Flexible ductwork should be almost fully extended

The guide states that the designer should consider the following when selecting a particular type of flexible duct:

- Temperature range
- Fire rating
- Resistance to air flow
- Airtightness characteristics
- Length restrictions if applicable
- Support requirements
- Flexibility
- Insulation values
- System pressure.

It adds that pressure losses from flexible ducts can be high, so lengths should be kept to a minimum and that flexible ducts should be fastened at each end using a proprietary band or mechanical fastenings.

It also states that care should be taken not to damage the flexible duct and to ensure that the required airtightness of the system is maintained.

#### 4.2.9 Flexible ductwork for making final connections

The document states that the use of flexible ductwork to supply diffusers is very convenient. However, it adds that such ductwork produces much greater pressure drops than those for the equivalent smooth galvanised ductwork.

#### 4.2.10 Supports for flexible ductwork

The document states flexible ducts have a higher resistance than conventional ductwork and should be supported in such a way that excessive sagging and consequent kinking of the duct is avoided.

#### 4.2.11 Test holes in flexible ductwork

The document states it is not practicable to make test holes or take test readings in metal or fabric flexible ducts. It adds that where readings are required, the test holes should be made in rigid ductwork.

#### 4.2.12 Maintenance of flexible ductwork

The document states that every 12 months a visual inspection of flexible ductwork should be undertaken for damage, security of fittings, deterioration and internal condition. It adds that detailed maintenance requirements for ductwork are set out in HVCA Standard Maintenance Specification volume 2: Ventilation and air conditioning.

### 4.3 CIBSE TM 43 – FAN COIL UNITS

#### 4.3.1 Overview of CIBSE TM 43

This document is intended as a guide to designers of chilled water fan coil unit systems, the manufacturers who build them, the contractors who install and commission them, and end users.

#### 4.3.2 Ductwork connections

The document states that all connecting ductwork should be independently supported from the fan coil unit and grille/diffuser plenums, in accordance with DW 144: Specification for sheet metal ductwork.

The guide also states that insulated rigid ductwork with swept bends should be used for main duct runs, with connections to the fan coil unit and grille/diffuser plenum boxes in flexible ductwork. Flexible ducting only for final connections and not to compensate for poorly installed or misaligned ductwork

It states that flexible ductwork should be of 600mm maximum length and be of acoustic grade if necessary. Connections should be made using suitable clamps or clips, ensuring that an airtight joint is made. Ductwork should then be insulated and taped down.

It adds that flexible corrugated ducting can impose high resistances if formed into tight bends and should therefore be extended so that it is internally as smooth as possible.

## 4.4 CIBSE TM 26 – HYGIENIC MAINTENANCE OF OFFICE VENTILATION DUCTWORK

### 4.4.1 Overview of CIBSE TM 26

This guide, together with HVCA and BSRIA documents, provides a comprehensive toolkit for the management and maintenance of most ductwork systems to satisfy best practice requirements.

### 4.4.2 Mechanical ventilation systems

The document states that the Approved Code of Practice and Guidance to the Workplace (Health, Safety and Welfare) Regulations, states that mechanical ventilation systems, including air conditioning systems, should be regularly and properly cleaned, tested and maintained to ensure they are kept free of anything which may contaminate the air.

## 4.5 ASSOCIATION FOR SPECIALIST FIRE PROTECTION (ASFP) – FIRE RATED AND SMOKE OUTLET DUCTWORK

### 4.5.1 Overview of ASFP – fire rated and smoke outlet ductwork

This publication is intended to assist the reader in understanding many of the essential details which play a significant part in ensuring that fire rated (which includes smoke outlet) ductwork is correctly designed and installed in accordance with current UK legislative requirements.

The purpose of the document is to assist those involved in the specification, installation, inspection and verification of Fire Rated Ductwork and to ensure that minimum performance standards are maintained which will contribute to ensuring that fire compartmentation systems are not breached prematurely.

### 4.5.1 Cautionary note to all ductwork designers, manufacturers and installers

Sections of this document emphasise that general purpose ventilation/air conditioning ductwork cannot be utilised as, or converted into, a fire rated ductwork system unless the construction/materials of the whole system are proven by test or assessment in accordance with the requirements of BS 476: Part 24.

### 4.5.2 Ductwork and fire

The document states that many ventilation ductwork systems offer little or no protection against fire spread and therefore, when ventilation ductwork penetrates building compartmentation, the guidance of BS 5588: Part 9[13] should be followed by adopting one of the three following techniques:

- Method 1: Protection using fire dampers;
- Method 2: Protection using fire resisting enclosures;
- Method 3: Protection using fire resisting ductwork.

The document also states that the guidance given in Approved Document B1 (Means of Escape) and B3 (Internal Fire Spread Structure) of the Building Regulations 1991 for England and Wales refers to BS 5588: Part 9 for alternative ways in which the integrity of compartments may be maintained where ventilation and air conditioning ductwork penetrate fire separating elements.

[13] Note that BS5588 has been superseded by BS 9999: 2008

### 4.5.3 Fire resistance of ductwork

The document refers to fire resisting ductwork as "A duct or ductwork used for the distribution or extraction of air, designed and tested to satisfy the criteria defined in BS 476: Part 24."

Fire resistance is the ability of a component or construction to satisfy, for a stated period of time, the appropriate criteria specified in the relevant part of BS 476. The following criteria are applied to fire rated ductwork.

- Stability: The ability of a duct, ductwork and the support system to remain intact and fulfil their intended function for a specified period of time, when tested to the requirements of BS 476: Part 24 (ISO 6944).
- Insulation: The ability of a duct or ductwork to maintain its separating function without developing temperatures on its external surface, outside the compartment in which the fire is present, which exceed:

  i) 140°C as an average value above ambient and/or

  ii) 180°C as a maximum value above ambient at any one point

  when tested for a specified period of time to the requirements of BS 476: Part 24. (ISO 6944)
- Integrity: The ability of a duct or ductwork to remain free of cracks, holes or openings outside the compartment in which the fire is present for a specified period of time, when tested to the requirements of BS 476: Part 24 (ISO 6944)

The document states that the term "Fire Rated Ductwork" is deemed to refer to a system as tested or assessed in accordance with BS 476 : Part 24. As the vast majority of tests on steel ducts are conducted with rigid ducts it is not appropriate to extrapolate this data for flexible steel ducts. Therefore, unless the flexible steel duct system has been tested in accordance with BS 476: Part 24, this guidance note cannot be assumed to apply.

### 4.5.4 Reaction to fire tests

The publication states that in order to restrict the use of materials in the construction of buildings which ignite easily, which have a high rate of heat release and/or which reduce the time to flash-over, reaction to fire tests are carried out on component materials and linings of ducts. These are carried out to show compliance with reaction to fire requirements in regulations or other specifications. The tests which are used to demonstrate compliance are:

- Method of test to determine the classification of the surface spread of flame of products - BS 476: Part 7. This test measures the rate at which flame is able to spread over the surface of a lining material. The material or product is classified 1,2,3 or 4 with Class 1 being the highest classification (least flame spread).
- Method of test for fire propagation for products - BS 476: Part 6. This test measures the rate of heat release from a product or material. From this test, indices of performance are calculated. Index of performance (I) relates to the overall test performance, whereas sub-index ($i_1$) is derived from the first three minutes of test.

  The maximum acceptable 'fire propagation' indices are specified in the various regulations.
- Method for assessing the heat emission from building materials - BS 476: Part 11, and Non-combustibility test for materials - BS 476: Part 4. These two tests are similar and are used to determine the heat emission from a product or material.

An additional product performance classification for lining materials defined in the national Building Regulations is Class 0. This is achieved if a material or the surface of a composite product is either:

- i) composed throughout of materials of limited combustibility, or
- ii) a Class 1 material which has a fire propagation index (I) of not more than 12 and sub index ($i_1$) of not more than 6.

Class 0 is not a classification identified in any British Standard test.

## 4.6 HVCA TR/19 – INTERNAL CLEANLINESS OF VENTILATION SYSTEMS

### 4.6.1 Overview HVCA TR/19

This publication establishes a level or particulate cleanliness verification for new and existing ventilation systems, includes guidelines to ensure that new ductwork systems are protected during installation and indicates when it is appropriate to clean systems in use.

### 4.6.2 Flexible ductwork

The document states that flexible ducts trap dirt in corrugations. This dirt can be difficult to remove if the corrugations are deep and/or compressed together.

It adds that lightweight foil, plastic flexible or aged flexible ducts are liable to damage and that cleaning methods must be adjusted to account for the type of flexible duct. Brush methods require soft bristle brushes and gentle application. Compressed air methods may require a pressure reduction to avoid tearing the material.

It also states that it may be necessary to remove and extend flexible ducts to release dirt from folds. Decay of the material of construction, or difficulty in releasing flexible ducts from their connection spigots without causing damage may make replacement a better option than cleaning.

## 4.7 HVCA SFG 20 – STANDARD MAINTENANCE SPECIFICATION FOR BUILDING SERVICES

### 4.7.1 Overview of SFG 20

This document is widely regarded as the industry standard for any businesses or individuals responsible for maintaining, managing or specifying the maintenance of building services.

### 4.7.2 Maintenance of flexible duct connections

The document states that flexible duct connections should be inspected every 12 months to check condition, leaks and secureness of fittings

## 4.8 BSRIA FMS1/97 - GUIDANCE TO THE STANDARD SPECIFICATION FOR VENTILATION HYGIENE

### 4.8.1 Overview BSRIA FMS 1/97

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.

### 4.8.2 Cleaning techniques for flexible ducting

The document proposes the following cleaning techniques for flexible ducting:

- Steam washing
- Mechanical brushing
- Air jetting
- High volume air blast
- Sectional extraction
- Sealing or encapsulation

The document describes the different cleaning techniques.

It classifies flexible ductwork as having a medium rate of dirt accumulation for supply, general return and extract systems.

## 4.9 BUILDING BULLETIN 100 – DESIGN FOR FIRE SAFETY IN SCHOOLS

### 4.9.1 Overview of building bulletin 100

This guide provides fire safety design guidance for schools in England and Wales. The guidance applies to nursery schools, primary and secondary schools, including sixth form colleges, academies and city technology colleges, special schools and pupil referral units.

The guide is intended for all those with an interest in fire safety in schools, but in particular designers, fire engineers, building control officers (or equivalent) and fire safety officers.

### 4.9.2 Mechanical ventilation and air conditioning systems

The document states that any system of mechanical ventilation should be designed to ensure that, in a fire, the ductwork does not assist in transferring fire and smoke through the building and put at risk the protected means of escape from the accommodation areas.

It refers to guidance on the use of mechanical ventilation is given in BS 5588-6:1991[14].

## 4.10 DISTRICT SURVEYORS ASSOCIATION (DSA) – GUIDE TO MECHANICAL AND ELECTRICAL SERVICES IN SPORTS GROUNDS

### 4.10.1 Overview of DSA guide to mechanical and electrical services

This document is a guide to electrical and mechanical services in sports grounds controlled under the Safety of Sports Grounds Act 1975 and the Fire Safety and Safety of Places of Sport Act 1987.

### 4.10.2 Mechanical ventilation and air conditioning systems

The guide states that requirements B1, B2 and B3 of the Building Regulations, which relate to means of escape and internal fire spread, apply to all building work in all types of premises.

[14] Note that BS5588 has been superseded by BS 9999: 2008.

It states that the major concerns are:

- The system could spread smoke, heat or flame from one compartment to the other
- Ductwork materials and machinery used within the system could contribute to any such spread
- The movement of air generated by the system could assist in drawing smoke towards exit doors or on to exit routes

The recommendations are:

- All mechanical ventilation systems should comply with the relevant requirements of BS 5720[15] and BS 5588 Part 9[16]
- Mechanical ventilation systems should have duct and flexible connections made of non-combustible material

[15] This British Standard has been withdrawn

[16] Note that BS5588 has been superseded by BS 9999: 2008.

# 5 CONSTRUCTION PROJECT SPECIFICATIONS

The aim of this section of the report is to examine how construction project teams specify flexible ductwork on their projects.

The content of this chapter has been compiled by referencing project specifications produced by the following companies:

- Aecom
- Arup
- Atkins
- Cudd Bentley
- Downie Consulting Engineers
- Hoare Lea
- Long and Partners
- MLM Consulting Engineers
- Silcock Dixon
- White Young Green
- WSP

The information was furnished by these organisations in strictest confidence, so the conetnt of the different project specifications is presnted in an anonymous manner.

## 5.1 SAMPLE SPECIFICATION 1

The following specification material was employed by four of the companies consulted for this study exercise. It is based on the National Engineering Specification (NES).

### 5.1.1 Design information - general

All ductwork and associated materials shall be manufactured, installed and tested, in accordance with the current editions of HVCA Specification DW/144 and DW 154 for sheet metal ductwork and plastic ductwork respectively, for low, medium and high pressure/velocity air systems, and as qualified in this specification.

### 5.1.2 Ductwork installation standards

Carry out construction and installation of ductwork in accordance with DW 144, DW 154, DW 172 and DW 191 and BS 5588[17] as appropriate.

The entire system installation shall comply with the requirements of the Building Control and Fire Officer.

### 5.1.3 Low pressure ductwork air leakage testing

Test low-pressure ductwork in accordance with DW 144 and DW143.

### 5.1.4 Flexible ducts - metal

Supply bendable ducts in accordance with DW 144 Part 7 Section 25. Flexible ducts shall be manufactured from light gauge coated steel, helically wound with lock seams of circular section.

Building Control and Fire Officer approvals shall be obtained for the use of the flexible ductwork to be installed.

Comply with BS EN 13180.

Maximum length of flex to be three diameters or 1m, whichever is the smaller.

Flexible ductwork used to make final connection between distribution ductwork and terminal units only shall be kept as short and straight as possible and shall not be used to take up gross misalignment.

Flexible duct shall be adequately supported to eliminate sagging.

Where the flexible ductwork is to be insulated, this shall be factory applied of a type approved for the application and to the thermal conductivity equivalent to the adjacent thermal insulation and shall be Class "O" fire rated.

The maximum frictional resistance to airflow per unit length of the flexible duct shall be agreed with the Designer. The radius ratio R/D for bends shall not be less than 2 where R is the centre line radius and D is the diameter of the flexible duct.

The flexible ductwork shall be to a standard of air tightness equal to that of the ductwork, and constructed to meet the fire precautions recommended in BS 5588 which comprise:-

- Fire resistance to meet BS 476: Part 6 with indices of performances not more than i equal to 12 and i equal to 6.

[17] Note that BS5588 has been superseded by BS 9999: 2008.

- Materials shall not produce smoke or toxic fume hazards if involved in a fire.

In no instances shall flexible duct connections be allowed on to fire dampers or through floors and walls

Flexible ducts shall be suitable for an operating temperature range of 18°C to 120°C.

The joints to rigid spigots shall be sealed with a jointing paste or mastic compound. Ducts up to 150mm diameter shall be secured with a worm-drive type hose-clip complying with BS 3628. Ducts over 150mm diameter shall be secured with a band clip.

5.1.5 Hangers and supports

Provide hangers and supports throughout in accordance with DW 144 Part Six, Section 19; DW 154 Part 5 or DW 191, Section 7 as appropriate.

5.1.6 Flexible ductwork – wire loop ties

Ensure that flexible ductwork does not become kinked or flattened. Support flexible ductwork using wire loop tie supports to prevent sagging.

5.1.7 Spherical and drum punkah louvre diffusers

When connecting to ends of flexible ducting, fit rigid flanged extension collar.

5.1.8 Diffuser – linear lighting/ air modular type

Fit spigot, suitable for flexible ducting joint connection to plenum box.

5.1.9 Internal cleanliness

Provide the level of care and protection as defined in HVCA document TR/19, level as scheduled.

5.1.10 Delivery

Provide adequate and safe protection for all materials and products during transport to site. Deliver all ductwork, tubes, conduit, trunking and associated equipment with open ends effectively plugged, capped or sealed.

## 5.2 SAMPLE SPECIFICATION 2

### 5.2.1 Ductwork installation standards

Carry out construction and installation of ductwork in accordance with DW 144, DW 154, DW 171, DW 191 and BS 5588[18] as appropriate.

### 5.2.2 General workmanship

Install ductwork in accordance with DW 144, DW 154 and DW 191 as appropriate. Ensure that there are no sharp edges or corners on cut edges on ductwork, flanges and supports. Install pre-insulated ductwork in accordance with manufacturer's instructions.

In no instances shall flexible duct connections be allowed onto fire dampers, or through floors or walls.

### 5.2.3 Ductwork supports

Support ductwork in accordance with DW 144 Part Six Section 19; DW 154 Part 5; or DW 191 Section 7 as appropriate. Install supports to ensure insulation can be applied unless otherwise indicated.

### 5.2.4 Coated steel flexible ducts

Supply and fasten coated steel flexible duct connections as DW 144 Part Seven Section 25.

Use flexible duct connections in applications listed in DW 144 paragraph 25.1.

Comply with BS EN 13180.

Maximum length 600mm.

### 5.2.5 PVC/Polyester laminate flexible ducts

Supply and fasten PVC/polyester laminate flexible duct connections as DW 144 Part Seven Section 25.

Use flexible duct connections in applications listed in DW 144 paragraph 25.1.

Comply with BS EN 13180.

Maximum length 600mm.

### 5.2.6 Internal cleanliness

Provide the basic level of cleanliness and protection as defined in HVCA TM2

### 5.2.7 Delivery

Provide adequate and safe protection for all materials and products during transport to site. Deliver all ductwork, tubes, conduit, trunking and associated equipment with open ends effectively plugged, capped or sealed.

[18] Note that BS5588 has been superseded by BS 9999: 2008.

## 5.3 SAMPLE SPECIFICATION 3

### 5.3.1 Ductwork installation standards

Carry out construction and installation of ductwork in accordance with DW 144, DW 154, and DW 171, as appropriate.

### 5.3.2 Bendable and flexible ducts

Provide un-insulated or pre insulated flexible duct as indicated on the Drawings. Where pre-insulated the insulation shall comply with the requirements of the 'Thermal Insulation Section' of the Specification.

Flexible ducts where required shall be neatly fixed and adequately supported so as to prevent sagging and transfer of weight to adjacent ductwork.

Flexible ducting used to connect terminals to distribution systems shall comply with BS EN 13180 and Part 7 of DW/144 and be constructed from non-combustible material or material which has a fire propagation index of not more than 12 and a sub-index of not more than 6 when tested to BS 476 Part 6.

High temperature flexible connectors installed on smoke extract ductwork systems shall be clearly labelled to indicate their rating and shall be colour-coded red.

Flexible ducts shall be continuous with no intermediate joints.

Flexible ducts shall not exceed 3 x nominal diameter in length and a maximum offset of 0.4 x nominal diameter.

The bending radius must be sufficient to prevent tensioning of the outside of the bend and restriction of the throat likely to cause deformation and/or leakage. In no case shall flexible ductwork be used to correct misaligned rigid ductwork.

The flexible ducts named below are deemed satisfactory for pressure loss, robustness and general fire resistance. Their acceptability for specific uses is not identical (especially where non-combustibility is specified) and the Sub-Contractor must ensure that an appropriate grade of material is installed.

All flexible ducts shall be approved by the Consulting Engineers prior to installation.

Jointing of flexible ducts to rigid ductwork and fittings shall comply with the relevant construction standard and test requirements. Nipples employing patented 'O' Ring or other similar joint may be put forward. Joint types and method shall be approved by the Consulting Engineers.

## 5.4 SAMPLE SPECIFICATION 4

### 5.4.1 Ductwork installation standards

All ductwork and associated materials shall be manufactured, installed and tested, in accordance with the current editions of HVCA Specification DW/144 and DW 154 for sheet metal ductwork and plastic ductwork respectively

### 5.4.2 Flexible ductwork – metal and fabric

Fit flexible ductwork as described in HVCA DW/144, Part 7, clauses 25 and 26, Pages 51-53, but excluding bendable ductwork unless otherwise specified.

Apply BS 476, Parts 6 and 7 and BS 9999.

Fit flexible ductwork of internal diameter equal to the external diameter of the rigid ductwork. Use minimum bend radius ratio R/D of 2 and a maximum length of 2 metres installed without kinking of the ductwork. Use flexible ductwork where specified and/or drawn.

Include a tear resistant fabric inner liner for flexible fabric ductwork.

Do not pass flexible ductwork through fire resistant building construction nor use at extract points where deposits of flammable substances are likely to occur in high fire risk areas.

Do not use flexible ductwork to change direction between sections of rigid ductwork.

Secure flexible ductwork to rigid ductwork by means of hose or band clips and ensure that the whole unit has a standard of airtightness equal to that of the rigid ductwork.

Ensure that flexible ductwork is suitable for an operating temperature range of -5°C to +90°C and complies with the following:

- B.S.476, Part 6, Fire Propagation - Index of Performance. I not exceeding 12 and i = 6.
- B.S.476, Part 7, Class 1, surface of very low flame spread.

## 5.5 SAMPLE SPECIFICATION 5

### 5.5.1 Ductwork installation standards

Carry out construction and installation of ductwork in accordance with DW 144, DW 154, and DW 171, as appropriate.

### 5.5.2 Flexible ductwork – metal and fabric

Fit flexible ductwork as described in HVCA DW/411 Specification, Part 7, Clauses 25 and 25, Pages 51and 52, but excluding bendable ductwork unless otherwise specified.

Apply CIBSE TM8, Part 7, B.S.476 Parts 6, 7 and 8, BSCP:413 and B.S.5588, Part 9.

Fit flexible ductwork of internal diameter equal to the external diameter of the rigid ductwork. Use minimum bend radius ratio R/D of 2 and a maximum length of 2 metres installed without kinking of the ductwork. Use flexible ductwork where specified and/or drawn.

Include a tear resistant fabric inner liner for flexible fabric ductwork.

Do not pass flexible ductwork through fire resistant building construction nor use at extract points where deposits of flammable substances are likely to occur in high fire risk areas.

Do not use flexible ductwork to change direction between sections of rigid ductwork.

Secure flexible ductwork to rigid ductwork by means of hose or band clips and ensure that the whole unit has a standard of airtightness equal to that of the rigid ductwork.

Ensure that flexible ductwork is suitable for an operating temperature range of -5°C to +90°C and complies with the following:

- B.S.476 : Part 6, Fire Propagation - Index of Performance. I not exceeding 12 and i = 6.
- B.S.476 : Part 7, Class 1, surface of very low flame spread.
- B.S.476 : Part 8, Fire Resistance of at least 15 minutes integrity.

## 5.6 SAMPLE SPECIFICATION 6

### 5.6.1 Ductwork installation standards

Carry out construction and installation of ductwork in accordance with DW 144, DW 154, and DW 171, as appropriate.

### 5.6.2 Flexible ductwork

Flexible ducting shall be provided for connections between ductwork, terminal units, diffusers and where indicated on the drawings. It shall comply with BS 476, the Building Regulations and to the requirements of the local Building Control.

The flexible connection shall not restrict airflow within the ductwork system, nor should the joint be used to correct x and y alignment of the ducts either side. Ensure that flexible ductwork does not become kinked or flattened.

Flexible connections shall be kept as short as possible and shall be supported rigidly to prevent movement due to air flow. All bends in flexible ducting shall be carefully formed to prevent puncturing on the inside radii with consequent increase in pressure drop.

Maximum lengths shall be 1.0 metre and all ducting shall be adequately supported to prevent oscillation and noise generation.

Steel wire helical reinforcement in flexible ducts is to be carried over the spigots of grilles and diffusers and connections to these items are to be painted matt black for the visible depth. Changes of direction shall be of long radius and no kinking or flattening of ducting will be allowed.

Joints shall be made by means of hose type metal clamps which tighten around the circumference of the ducting and be finally sealed with 100 mm wide plastic adhesive tape.

Flexible ducting shall be of the insulated type for all supply air ductwork and of the un-insulated type for return air ductwork.

Flexible ducting shall be rot, fungus and corrosion resistant and shall generally be constructed with a woven fibreglass coated with neoprene inner lining, galvanised steel helical spring and a woven fibre-glass impregnated and coated with neoprene outer cover retaining a neoprene impregnated reinforcement cord.

On supply air ductwork where the surrounding air dew point temperature is below the supply air temperature an additional 25 mm of mineral fibre flexible insulation shall be provided with a suitable vapour barrier.

The dimensions and mechanical requirements of flexible ducts shall comply with BS EN 13180.

The flexible duct manufacturer's recommendations for minimum turning radius must be followed.

Offsets and bends must be minimised, and must not cause regenerated noise or excessive pressure drops by constricting flow.

## 5.7 SAMPLE SPECIFICATION 7

### 5.7.1 Ductwork installation standards

Supply and install all ductwork as and where shown on the drawings. All shall be in accordance with HVCA standard DW144 and shall be classed as low velocity.

### 5.7.2 Flexible ductwork

Supply and install where shown flexible ductwork.

Ductwork shall be compressible flexible and connected via spun cone or square to round transition to and from rectangular ductwork.

Metal worm drive clamping band to apply uniform pressure around the entire circumference of the connection to provide an airtight join shall be used.

Thickness shall be not less than 25mm of mineral wool sheathed in polythene or other approved material.

The duct shall be installed to ensure the inner radius of the bend to be not less than the diameter of the duct and the duct is not compressed flat or substantially changed in its cross section.

Flexible ductwork shall be suspended by bands at not less than one metre centres to prevent sagging and distortion. All ductwork shall be suspended to prevent contact with the ceiling.

All ductwork shall be non-ignitable, no spread of flame and no smoke development in accordance with the Building Regulations.

## 5.8 SAMPLE SPECIFICATION 8

### 5.8.1 Ductwork installation standards

Supply and install all ductwork as and where shown on the drawings. All shall be in accordance with HVCA standard DW144 and shall be classed as low velocity.

### 5.8.2 Bendable and flexible ducts

Non-rigid ducts shall be of bendable aluminium, flexible metal or flexible fabric construction.

The maximum length of each non-rigid section shall be 600mm.

Changes in direction shall be formed in long radius. Bends where necessary shall be two per length with 90° minimum included angle. Minimum throat radius shall be one diameter.

Adequate support shall be provided to prevent sagging. Kinked or flattened non-rigid ductwork will be rejected.

Test holes required shall be formed in rigid ductwork adjacent to flexible sections.

Ducting shall comply with air-tightness requirements for rigid ducts in the same system.

Where required, ducts shall be insulated with soft-formed insulant with external finish.

Reinforcement of flexible fabric ducts shall be carried over air terminal and rigid duct branch spigots and secured with worm-drive clips and sealant as recommended by the manufacturer.

## 5.9 SAMPLE SPECIFICATION 9

### 5.9.1 Ductwork

The Sub-Contractor shall design, supply and install ductwork systems to the following standards: Low Pressure Class A All areas

The Sub-Contractor shall produce fully detailed and comprehensive fabrication drawings, and shall manufacture ductwork in accordance with DW 144, DW 151 and DW 191,as appropriate.

The ductwork installation shall fully meet the requirements of DW144.

All ductwork shall comply with the requirements of BS 476 part 24

Flexible ductwork shall be avoided and minimised.

### 5.9.2 Flexible ductwork

Flexible ductwork shall be utilised between ductwork and equipment or grilles/diffusers only.

It shall be secured by worm drive clips and sealing compound, such that it is capable of withstanding the maximum pressure produced in the system under either normal or testing conditions.

Connection lengths shall not exceed 250mm unless specifically agreed in advance by the Contract Administrator.

Flexible ductwork shall not be used to form bends and/or fittings.

Pre-insulated flexible ductwork shall not be installed.

Unless noted otherwise elsewhere in this Specification or on the Contract Drawings, all flexible ductwork shall be hand-bendable, aluminium spiral wound, crimp locked strip rated at not less than 300°C.

### 5.9.3 Ductwork cleaning

The ventilation systems shall be designed and installed in full accordance with the requirements of HVCA document TR19.

# 6 CLIENT SPECIFICATIONS AND GUIDES

Major organisations such as the Department of Health and the Ministry of Defence produce specifications and technical guidance for construction project teams

The aim of this chapter is to examine the client specifications and guidance related to flexible ductwork.

## 6.1 HEALTH TECHNICAL MEMORANDUM 03-01: SPECIALISED VENTILATION FOR HEALTHCARE PREMISES

### 6.1.1 Overview of HTM 03-01

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

### 6.1.2 General requirements

The equipment built into the ventilation system and its ductwork should be of a type that will neither cause nor sustain combustion.

No materials that could sustain biological activity should be used in the construction or assembly of the system.

### 6.1.1 Ducting

Ducting is the means by which air is conveyed from the intake to its point of use. It is usually constructed of galvanised steel and will normally be insulated to reduce noise and conserve energy.

Ducts can also be formed in concrete, brickwork, stainless steel or plastic, and may be rigid or flexible.

### 6.1.2 Standard ductwork fittings

All fittings should conform to current HVCA specification DW144.

### 6.1.3 Other fittings

Fittings that have abrupt changes in direction and sharp edges should be avoided, as this will increase turbulence, thus increasing pressure loss and causing noise generation.

### 6.1.4 Flexible ducting

Flexible ductwork is unsuitable for air distribution in healthcare applications. It should only be used to make the final connection to a terminal.

Flexible ductwork may be used for final connections to grilles and diffusers, provided it is constructed to meet the fire precautions recommended in BS 8313. It must not pass through fire compartment or sub-compartment enclosures, or through cavity barriers.

Flexible ducting will cause a significant frictional loss and may be difficult to clean without damage. It should never be used in lieu of a bend. Where installed, it should take the most direct route and be as short as possible, never exceeding 1 m in length.

### 6.1.5 Standard of installation

During the installation of the system, the following must be witnessed by either the client or his representative:

- that the plant and installations have been provided and installed in accordance with the design specification and drawings;
- that only approved sealants have been used in the installation;
- that all components function correctly;
- that the satisfactory sealing of access doors and viewing ports have been carried out;
- that air-pressure tests and air-leakage tests on ventilation ducting have been carried out in accordance with the methods set out in the HVCA's (1998) 'DW/143

### 6.1.6 Cleanliness of installation

During installation it must be established that ductwork is being installed to the "advanced level" as defined in the HVCA's (2005) 'TR/19 – Guide to good practice: internal cleanliness of ventilation systems'.

This specifically includes ensuring that ductwork sections arrive on site and are stored with their open ends sealed and that open ends remain sealed during installation to prevent the ingress of builders' dust.

### 6.1.7 Ventilation system cleaning

Duct-cleaning equipment that uses rotating brushes or a vacuum unit can easily damage flexible sections of ductwork.

On completion of cleaning, all flexible duct sections should be checked for rips and tears. The straps that secure them to rigid duct sections and air terminals should also be checked to ensure that there is no air leakage.

## 6.2 FIRECODE – FIRE SAFETY IN THE NHS HEALTH TECHNICAL MEMORANDUM 05-02: GUIDANCE IN SUPPORT OF FUNCTIONAL PROVISIONS FOR HEALTHCARE PREMISES

### 6.2.1 Overview of HTM 05-02

The purpose of this document is to provide guidance on the standards of fire safety expected in healthcare premises.

It is the starting point for fire precautions in all healthcare buildings, and where appropriate, directs the user to Approved Document B of the Building Regulations

### 6.2.2 Design of HVAC systems

The document states that ventilation systems should be designed and installed to comply with Health Technical Memorandum 03-01 – Specialised ventilation for healthcare premises, and BS 5588-9[19].

[19] Note that BS5588 has been superseded by BS 9999: 2008.

### 6.2.3 Ventilation ductwork

The document states that ventilation ductwork should comply with the requirements of BS 5588-9 and Health Technical Memorandum 03-01 – Specialised ventilation for healthcare premises.

## 6.3 NATIONAL HEALTH SERVICE (NHS) MODEL ENGINEERING SPECIFICATION C04: MECHANICAL VENTILATION AND AIR CONDITIONING SYSTEMS

### 6.3.1 Flexible ductwork

The specification states that flexible ductwork shall be used for final connections to grilles and diffusers only if shown on the drawings and specified.

It states that flexible ductwork should be installed to a standard of airtightness equal to that of the ductwork and constructed to meet the fire precautions recommended in BS 5588[20], which comprise:

- Length of flexible ductwork branches not to be longer than 1 meter, or pass through fire compartment walls, floors or enclosures of sub-compartment walls or enclosures or cavity barriers
- Fire resistance to meet BS 476: Part 6 with indices of performance not more than I =12 and I =6

## 6.4 MOD SPECIFICATION 037 – AIR CONDITIONING, AIR COOLING AND MECHANICAL VENTILATION IN BUILDINGS[21]

### 6.4.1 Overview of MOD specification 037

This specification details the design and other requirements for air conditioning, air cooling and mechanical ventilation for buildings.

### 6.4.2 Bendable and flexible ducts

Bendable ducts and flexible ducts shall be metal, plastic coated metal or non-metallic type as indicated.

Where bendable ducts and flexible ducts are specified, the internal diameter of the duct shall be equal to the external diameter of the rigid duct or equipment spigot. Flexible ducts in other situations shall only be used with the approval of the PM. The maximum length of any individual duct shall not exceed 3m.

Non-metallic ducts shall have a liner and a cover of tough tear resistant fabric. The fabric shall be impregnated and coated with plastics and reinforced with a bonded galvanised steel spring, stainless steel or other approved wire helix between the liner and the cover. An outer helix of glass fibre cord, or equal, shall be bonded to ensure regular convolutions. Flexible ductwork without a liner may be used subject to compliance with all the other appropriate requirements of this section.

Metallic ducts shall consist of corrugated metal tubing of stainless steel, aluminium, galvanised steel or aluminium coated steel. The metal surface(s) may be coated with a plastics material.

The frictional resistance to air flow per unit length of bendable duct or flexible duct shall not exceed 150% of the frictional resistance per unit length of galvanised steel duct of

[20] Note that BS5588 has been superseded by BS 9999: 2008.

[21] This document was formerly PSA Standard Specification (M&E) No 100

similar diameter. The radius ratio R/D for bends shall be not less than 2, where R is the centre line radius and D is the diameter of the duct.

The leakage from any section of bendable duct or flexible duct shall meet the requirements for airtightness applicable to rigid ductwork for the pressure classification specified.

Unless otherwise indicated, bendable ducts and flexible ducts shall be suitable for an operating temperature range of -5°C to +90°C and shall comply with BS 476 as follows: Part 12 – having Class P rating: Part 6 – having an index of performance (I) not exceeding 12, of which not more than 6 should be derived from the initial period of test; Part 7 – be Class 1 rated (surface of very low flame spread)

Test holes shall not be formed in bendable nor flexible ductwork

# 7 AMERICAN STANDARDS

A wide variety of American construction industry guidance is produced by organisation such as The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), The Sheet Metal and Air Conditioning Contractors Association (SMACNA), The Air Diffusion Council (ADC) and The National Fire Protection Association (NFPA).

These documents are designed for voluntary use and do not impose any regulations. However, laws and regulations may refer to certain guidance and standards as ways of complying with specific requirements.

The aim of this chapter is to examine American construction industry guidance related to flexible ductwork.

## 7.1 SMACNA – HVAC DUCT CONSTRUCTION STANDARDS

### 7.1.1 General performance requirements for all ducts

This SMACNA document states that in fulfilling the function of moving air, the duct assembly must satisfy certain fundamental performance criteria:

- Dimensional stability (shape deformation and strength).
- Containment of the air being conveyed (leakage control)
- Vibration (fatigue and appearance).
- Noise (generation, transmission, or attenuation).
- Exposure (to damage, weather, temperature extremes, flexure cycles, wind, corrosive atmospheres, biological contamination, flow interruption or reversal, underground or other encasement conditions, combustion, or other in-service conditions).
- Support (alignment and position retention).
- Seismic restraint.
- Thermal conductivity (heat gain or loss and condensation control)

### 7.1.2 Flexible duct installation standards

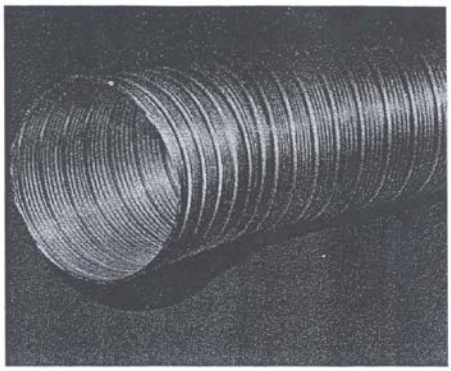
This SMACNA document provides the following guidance about flexible duct installation standards:

- Unless otherwise stated, the term "flexible air duct" is used for all ducts classified by Underwriters Laboratory (UL) as either flexible air ducts or connectors
- It is presumed that project specifications define the specific materials, pressure limits, velocity limits, friction rate, thermal conductivity, acoustical ratings, and other attributes.
- When ducts must conform to NFPA Standard 90A or 90B, flexible ducts must be tested in accordance with Underwriters Laboratories *UL Standard for Safety for Factory-Made Air Ducts and Connectors,* UL-181, and must be installed in accordance with the conditions of their UL listing.
- The minimum length of flexible duct should be used.

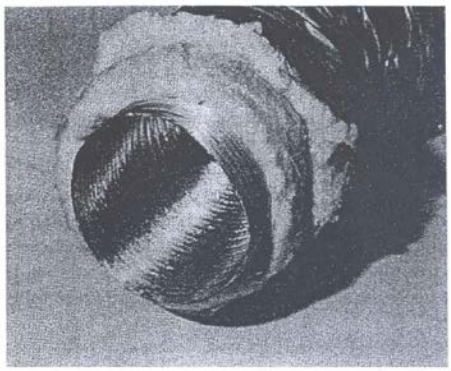
- Bends shall be made with not less than one duct diameter centreline radius. Ducts should extend a few inches beyond the end of a sheet metal connection before bending. Duct should not be compressed.

- If the application guidelines dictated by the flexible duct manufacturer are more stringent than the specifications in this manual, those of the manufacturer shall govern.

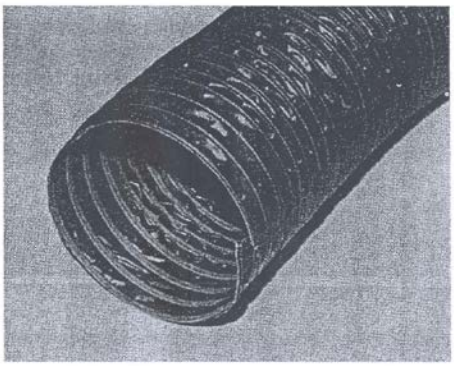
The SMACNA document provides the following illustrative guidance types of flexible ducts and accessories.



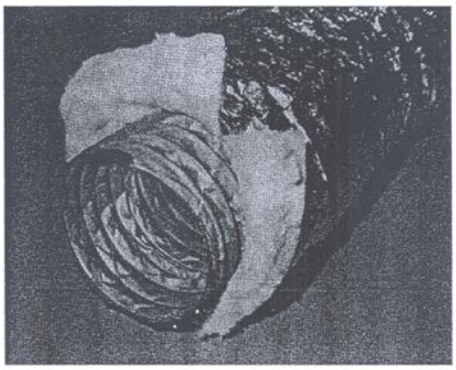
Form "M – UN" — Metallic, uninsulated
(Figure A)



Form "M – I" — Metallic, insulated
(Figure B)



Form "NM – UN" — Nonmetallic, uninsulated
(Figure C)



Form "NM – IL" — Nonmetallic, insulated (lined)
(Figure D)

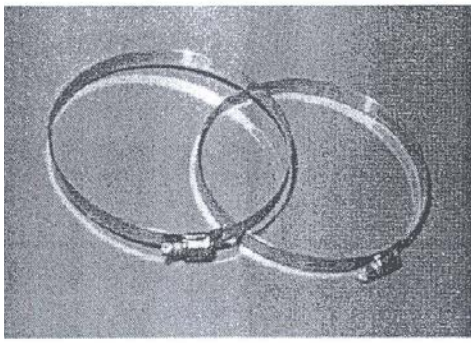


Figure A — Metal Clamp

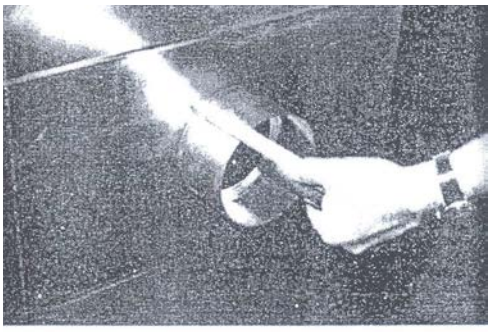


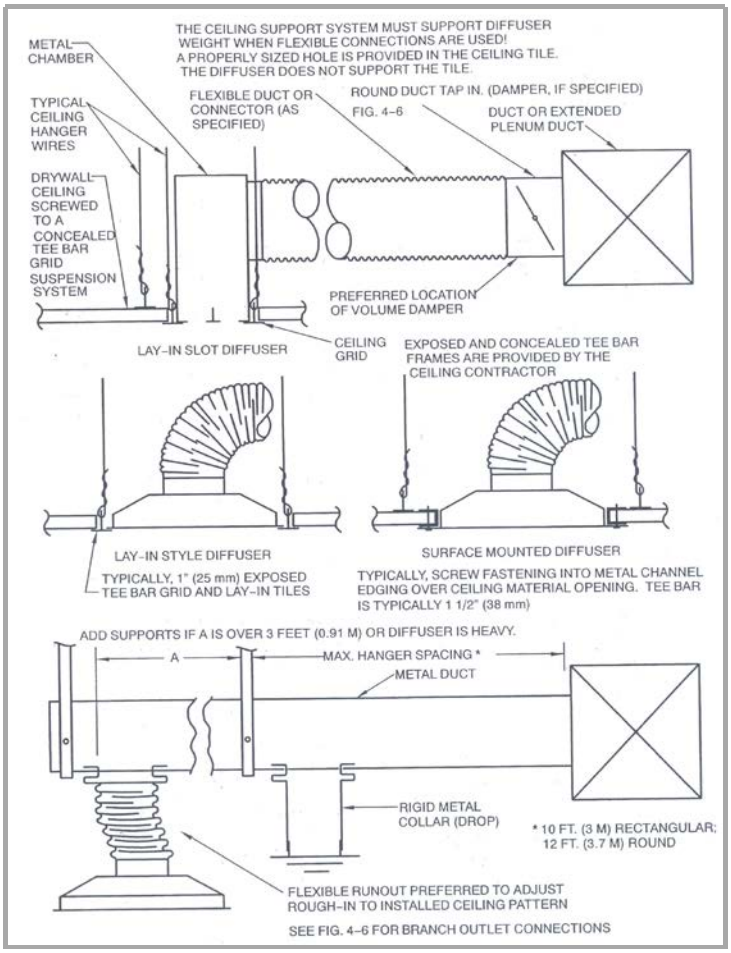
Figure H — Collar in duct min. 2"

### 7.1.3 Specification for joining and attaching flexible duct

This SMACNA document provides the following guidance about joining and attaching flexible duct:

- Adhesives shall be chemically compatible with materials they contact.
- The ends of ducts shall be trimmed square before installation.
- Collars to which flexible duct is attached shall be a minimum of 2 in (51 mm) in length. Sleeves used for joining two sections of flexible duct shall be a minimum of 4 in (102 mm) in length.
- Collars and sleeves shall be inserted into flexible duct a minimum of 1 in. (25 mm) before fastening.
- Metallic flexible duct shall be attached with at least three #8 sheet metals screws equally spaced around the duct's circumference. Ducts larger than 12 in (305 mm) in diameter shall have at least five #8 sheet metal screws. Screws shall be located at least ½ in (13 mm) from the duct end.
- Non-metallic flexible duct shall be secured to the sleeves or collar with a draw band. If the duct collar exceeds 12 in (305 mm) in diameter the draw band must be positioned behind a bead on the metal collar.
- Insulation and vapour barriers on factory-fabricated ducts shall be fitted over the core connection and shall also be secured with a draw band.

The SMACNA document provides the following illustrative guidance about joining and attaching flexible ducts



### 7.1.1 Specification for supporting flexible duct

This SMACNA document provides the following guidance about joining and attaching flexible duct:

- Flexible duct shall be supported at the manufacturer's recommended intervals but at least every 5 ft (1.5 m). Maximum permissible sag is a ½ in per foot (41.7 mm/m) of spacing between supports. A connection to another duct or to equipment is considered a support point.

- Hanger or saddle material in contact with the flexible duct shall be wide enough so that it does not reduce the internal diameter of the duct when the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1 in. (25 mm) wide. Narrower hanger material may be used in conjunction with a sheet metal saddle that meets this specification. This saddle must cover one-half the circumference of the outside diameter of the flexible duct and fit neatly around the lower half of the duct's outer circumference.

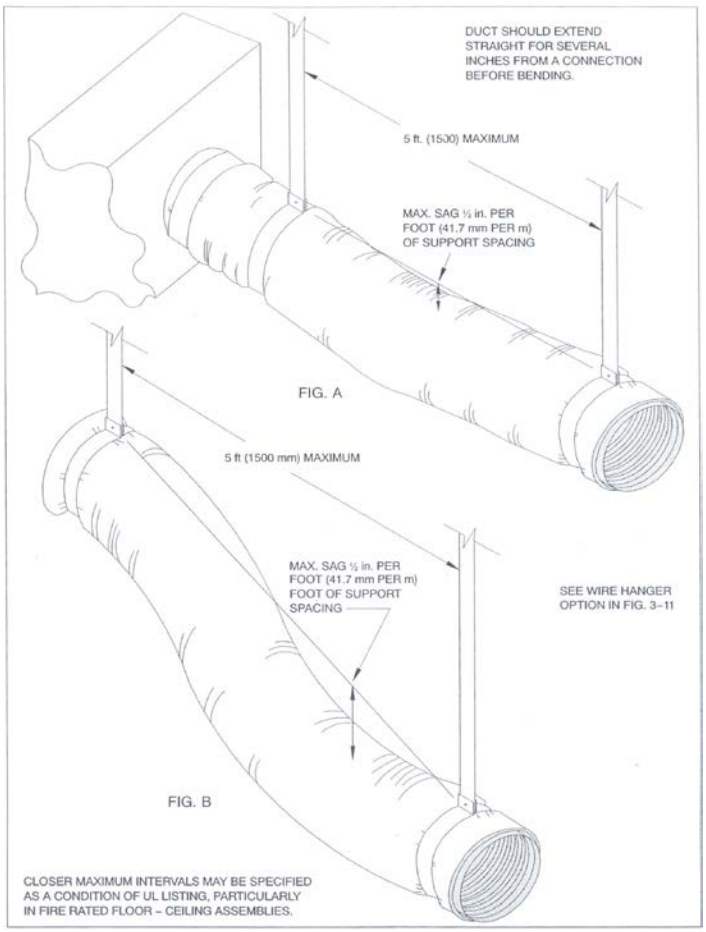
- Factory-installed suspension systems that are integral to the flexible duct are acceptable for hanging when the manufacture's recommended procedures are followed.

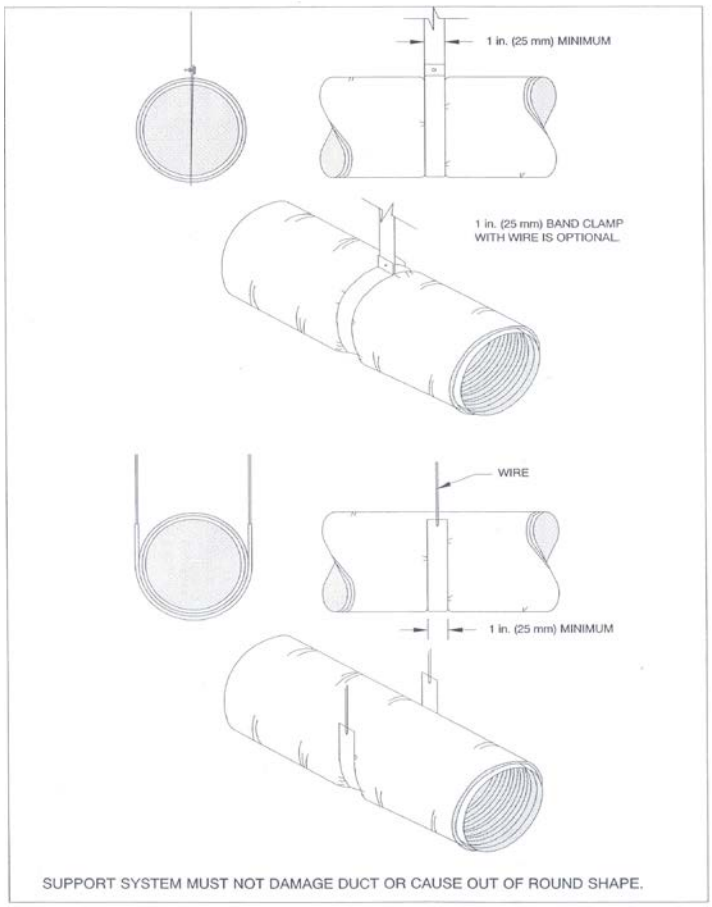
- Hangers shall be adequately attached to the building structure.

- To avoid tearing the vapour barrier, do not support the entire weight of the flexible duct on any one hanger during installation. Avoid contacting the flexible duct with sharp edges of the hanger material.

- Terminal devices connected by flexible duct shall be supported independently of the flexible duct

The SMACNA document provides the following illustrative guidance about the support of flexible ducts.


DUCT SHOULD EXTEND STRAIGHT FOR SEVERAL INCHES FROM A CONNECTION BEFORE BENDING.
5 ft. (1530) MAXIMUM
MAX. SAG ½ in. PER FOOT (41.7 mm PER m) OF SUPPORT SPACING
FIG. A
5 ft (1500 mm) MAXIMUM
MAX. SAG ½ in. PER FOOT (41.7 mm PER m) FOOT OF SUPPORT SPACING
SEE WIRE HANGER OPTION IN FIG. 3-11
FIG. B
CLOSER MAXIMUM INTERVALS MAY BE SPECIFIED AS A CONDITION OF UL LISTING, PARTICULARLY IN FIRE RATED FLOOR – CEILING ASSEMBLIES.


1 in. (25 mm) MINIMUM
1 in. (25 mm) BAND CLAMP WITH WIRE IS OPTIONAL.
WIRE
1 in. (25 mm) MINIMUM
SUPPORT SYSTEM MUST NOT DAMAGE DUCT OR CAUSE OUT OF ROUND SHAPE.

## 7.1 SMACNA – HVAC SYSTEMS DESIGN

### 7.1.1 General requirements

This SMACNA document states that practical performance requirements and construction standards must be established for:

- Dimensional stability – deformation and deflection
- Containment of the air being conveyed
- Vibration
- Noise generation, transmission and attenuation
- Exposure to damage, weather, temperature extremes, flexure cycling, chemical corrosion and other in service conditions.
- Structural support
- Emergency conditions including fire and seismic occurrence
- Heat gain and loss of the air stream
- Dirt and contaminants collecting on duct interior walls and duct liners

### 7.1.2 Duct system specification checklist

This SMACNA document states that in addition to SMACNA duct construction standards, specifications and retail drawings should include the following duct system requirements:

- Local code requirements
- Duct system static pressure classifications, standard flag designation
- Duct material selection
- Allowable duct leakage, specify sealing system classification
- Insulation requirement, external and liner
- Sound control devices and methods
- Outlets and inlet performance
- Filters
- Dampers – fire, smoke, and volume control – and their location, size and type
- Duct mounted apparatus
- Duct mounted equipment
- Special duct suspension requirements – such as seismic bracing, see SMACNA Seismic Restraint Manual

## 7.2 Air Diffusion Council (ADC) – Flexible duct performance and installation standards

### 7.2.1 Overview of ADC flexible duct performance and installation standards

This standard is intended for use by the HVAC industry, including manufacturers, designers, installers, contractors, code bodies, inspectors and end users. It is intended to be used as a comprehensive document in evaluating, selecting, specifying and installing flexible duct in heating, air conditioning and ventilating systems.

This standard sets forth specific methods of classifying, testing and marking flexible air ducts for indoor comfort heating, ventilating and air conditioning applications. This standard sets forth instructions for properly installing flexible ducts in air distribution systems.

This standard includes requirements for both insulated and non-insulated flexible ducts. No attempt is made in this standard to designate a specific material or construction.

### 7.2.2 Characteristics of flexible ducts

This standard provides the following illustrative guidance about flexible duct characteristics.

**2.1 Description**

Flexible ducts usually are packaged in compressed form in a variety of lengths with plain ends or as-semblies with special end fittings attached to either or both ends. Diameters generally range from 2" [50 mm] through 12" [300 mm] in 1 in. [25 mm] increments and 14" [350 mm] through 22" [560 mm] in 2 in. [50 mm] increments. Most flexible ducts are slightly over-sized in diameter to fit over standard sheet metal fittings (see "Dimensions and Tolerances" in Section 3.5).

**2.2 Typical Styles**

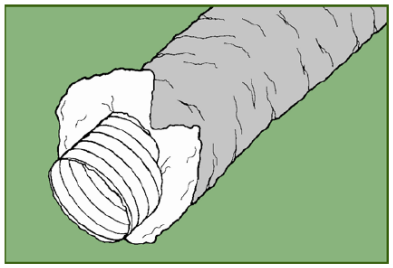


***Figure 1*** *Style NM-IL - Nonmetallic, Insulated, Lined (Non porous Inner Core)*

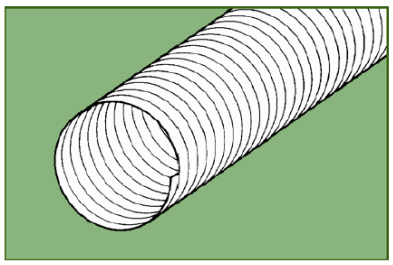


***Figure 2*** *Style NM-UN Nonmetallic, Uninsulated*

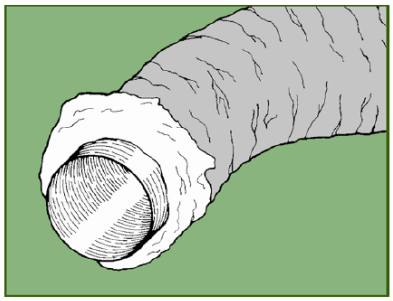


***Figure 3*** *Style M-I - Metallic, Insulated*

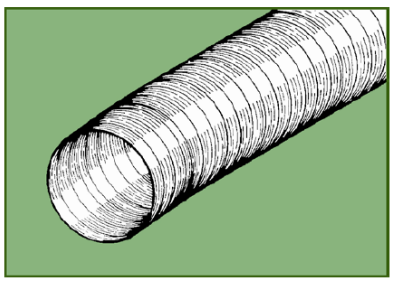


***Figure 4*** *Style M-UN - Metallic, Uninsulated*

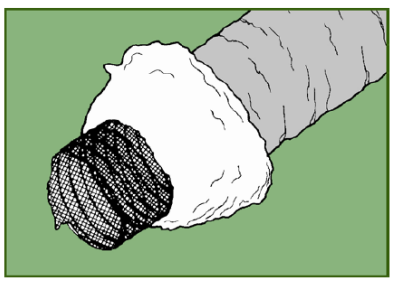


***Figure 5*** *Style NM-IP - Nonmetallic Insulated, Perforated (Porous Inner Core)*

### 7.2.3 Fire safety and flexible ductwork

This standard states that Flexible ducts cannot be considered "noncombustible", except metallic non-insulated ducts, but they are generally regarded as "limited-combustible". The UL 181 Safety Standard for "Factory-Made Air Ducts and Air Connectors" is used to investigate safety performance.

Is states that four fire tests are used to investigate the flammability and burning characteristics of flexible duct as follows:

- The Surface Burning Characteristics (Flame Spread and Smoke Development) for both interior and exterior of duct using the 25 ft. [7.6 m] tunnel test method that is published in UL 723, the American Society of Testing and Materials (ASTM E84), the National Fire Protection Association (NFPA 255) and the American National Standards Institute (ANSI).
- Ease of ignition/burning test using a Bunsen burner on both the inner core and outer jacket of the duct.
- Flame penetration test using a specially designed test apparatus to evaluate the retardation of flame passage from exterior to interior of the duct.
- Component flame resistance test conducted on tapes, fabrics, adhesives, and related components that are exposed directly to the air system.

### 7.2.4 Flexible ductwork air leakage

This standard states a higher than expected leakage rate can occur at connections if improper materials or careless work practices are used. To assure a low leakage rate for flexible duct systems, the following is required:

- Reference applicable industry manuals (SMACNA, NAIMA) for making round tap-ins into and sealing fitting joints to rigid ducts, plenums, etc.
- Make flexible duct connections/splices in accordance with the manufacturer's recommended installation instructions or this Standard.
- Seal flexible duct connections with sealing materials listed and labelled to Standard UL 181B. Mechanically secure connections with approved clamping material.
- Repair any rip, tear or hole in the air barrier using materials listed and labelled to Standard UL 181B and methods recommended by the manufacturer.

### 7.2.5 Installation requirements for flexible ducts

The document states that ducts conforming to NFPA 90A or 90B shall meet the following requirements:

- Shall be tested in accordance with Sections 7 to 23 of Underwriters Laboratories Standard for Factory-Made Air Ducts and Air Connectors, UL 181.
- Shall be installed in accordance with the conditions of their listing.
- Shall be installed within the limitations of the applicable NFPA 90A or 90B Standard.

The standard also states that there are specific restrictions and limitations related to the use of flexible ducts. Some are due to NFPA Standards, model codes and various state/local codes. Others are due to end use performance where the product was not designed for that specific use. Some, but not all inclusive, are as follows:

- Shall not be used for vertical risers serving more than two stories in height.
- Shall not be used in systems with entering air temperature higher than 250°F [121°C].
- Shall be installed in accordance with the conditions of their listing.
- When installed in a fire-rated floor/roof ceiling assembly, ducts shall conform with the design of the tested fire-resistive assembly.
- Shall be interrupted at the immediate area of operation of electric, fossil fuel or solar energy collection heat sources to meet listed equipment clearances specified.
- Air Connectors (does not apply to Air Ducts) shall not be installed in lengths greater than 14 ft. [4.3 m] for any given run; shall not pass through any wall, partition or enclosure of a vertical shaft with a 1 hour or more fire resistive rating; shall not pass through floors.
- Shall not penetrate walls where fire dampers are required.
- Shall not be used outdoors unless specifically designed to withstand exposure to direct sunlight and the weathering elements.
- Shall not be used to vent appliances for cooking, heating and clothes drying unless approved and recommended by the appliance manufacturer.
- Shall not be installed in concrete, buried below grade or in contact with the ground

The standard states that the routing of flexible duct, the number of bends, the degrees in each bend, and the amount of sag or direction changes (snaking) allowed between support joints will have serious effects on system performance due to the increased resistance each introduces

It provides the following illustrative guidance about installation requirements for flexible ducts.

### 4.4 Installation and Usage

Install ducts fully extended. Do not install in the compressed state or use excess length as this will noticeably increase friction losses. (Refer to Section 4.5 for more specific information regarding pressure loss and duct sizing.)

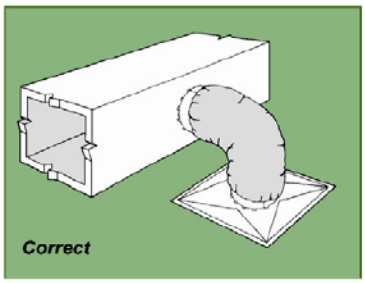



***Figure 6 -*** *Minimum duct length and bend radius reduces pressure drop and improves airflow.*

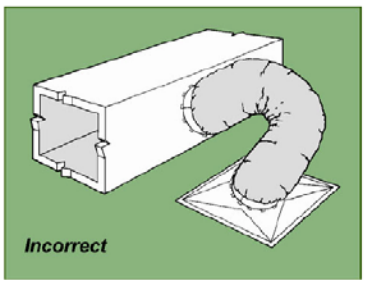



***Figure 7 -*** *Excess length and tight bend radius increases pressure drop and reduces airflow.*

Do not bend ducts across a sharp corner of building materials such as joists or truss supports.

The bend radius at the center line of ducts shall be equal to or greater than one duct diameter (See Figures 8 and 11). Sharper bends increase pressure drop significantly and reduce airflow.

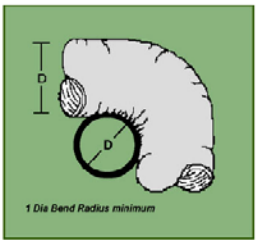



***Figure 8 - Correct.*** *Minimum 1 duct diameter bend radius reduces pressure drop and improves air flow.*

Avoid incidental contact with metal fixtures, water lines, pipes, or conduits. Do not install near hot equipment (e.g. furnaces, boilers, steam pipes, etc.) that is above the recommended flexible duct use temperature.

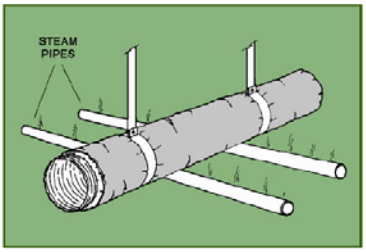



***Figure 9 - Incorrect****. Contact with steam pipes.*

**d.** Keep bends greater than or equal to one (1) duct diameter bend radius.

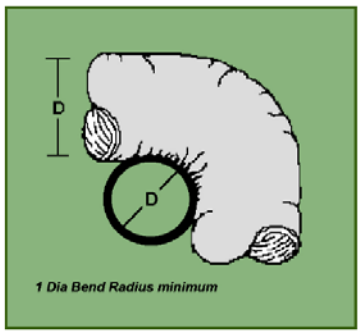



***Figure 11***

**e.** Properly route and support the flexible duct runs.

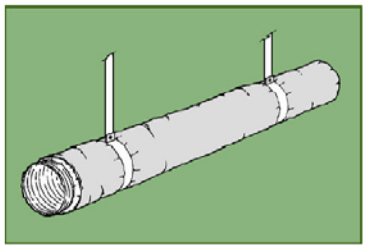


***Figure 12***

Care shall be taken to minimize sagging or snaking of the duct between supports and minimize pressure loss caused by excessive direction changes to the airflow.

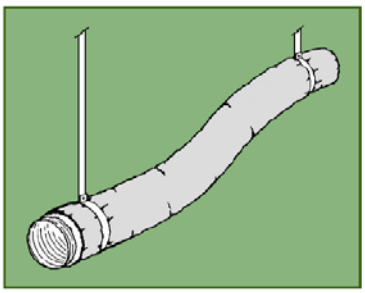


***Figure 13***

Ducts shall not be crimped against joist or truss members, pipes, wires, etc. as this increases pressure loss and reduces air flow.

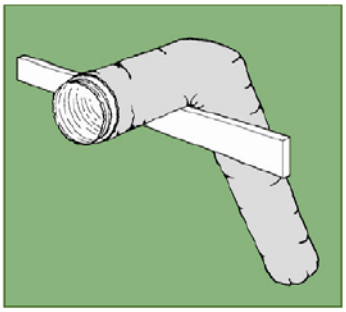


***Figure 14***

### 7.2.1 Supporting flexible duct

The document provides the following illustrative guidance about the support of flexible ducts.

**4.6 Supporting Flexible Duct**

Flexible duct shall be supported at manufacturer's recommended intervals, but at no greater distance than 4' [1.2 m]. Supporting shall be provided so that the maximum centerline sag is ½ " per foot [42 mm per meter] of spacing between supports (See Fig 19). A connection to rigid duct or equipment may be considered a support joint.

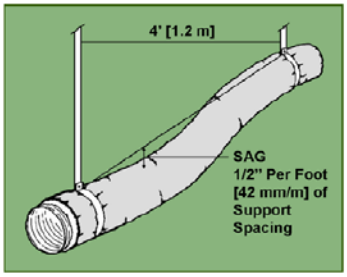



*Figure 19*

Long horizontal duct runs with sharp bends shall have additional supports before and after the bend approximately one duct diameter from the center line of the bend (See Fig 20).

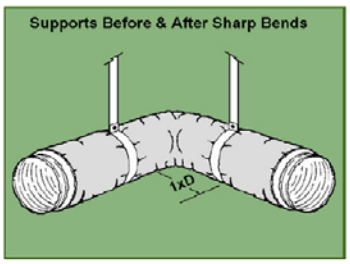



*Figure 20*

Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1½ " [38 mm] wide (See Fig 21).

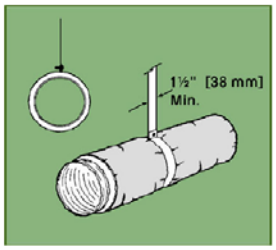



*Figure 21*

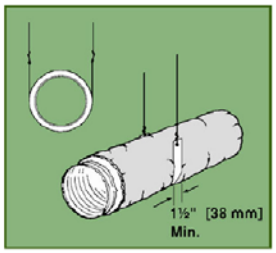



*Figure 22*

Do not secure support straps in a manner that compresses the inner core and constricts the air flow. Care shall be taken to insure the vapor barrier and insulation material are not excessively compressed by the support straps. Compressing the insulation could lead to condensation at the point of contact between the duct and the strap or saddle material.

Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when manufacturer's recommended procedures are followed.

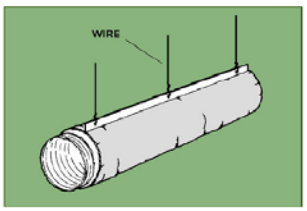



*Figure 23*

Support the duct between a metal connection and bend by allowing the duct to extend straight for at least one duct diameter before making the bend. This will avoid possible damage of the flexible duct by the edge of the metal collar and allow for efficient air flow and fitting performance (See Fig 25).

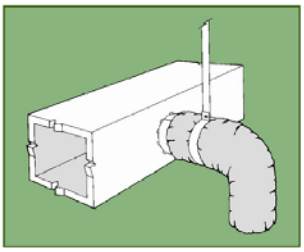


*Figure 25*

Flexible ducts may rest on ceiling joists or truss supports. Maximum spacing between supports shall not exceed the maximum spacing per manufacturer's installation instruction.

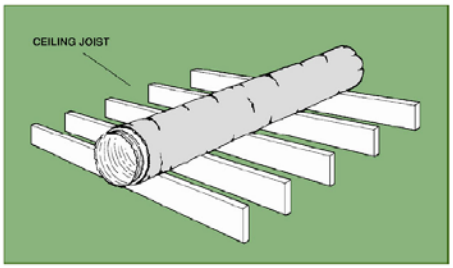



*Figure 24*

Vertically installed ducts shall be stabilized by support straps at a max. of 6' [1.8 m] on center.

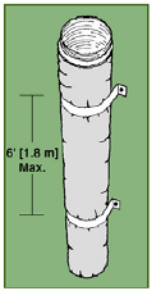



*Figure 26*

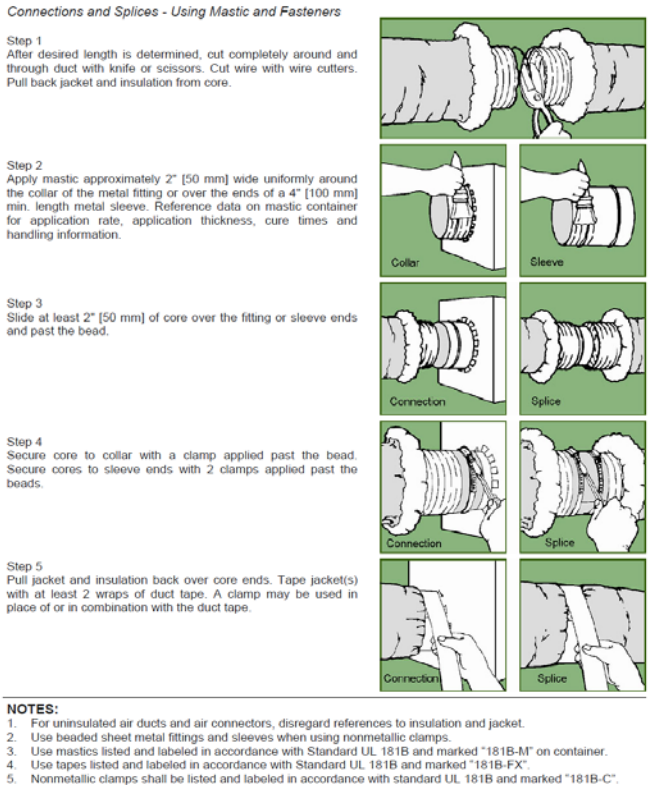
***Note:***
Factory-made air ducts may not be used for vertical risers in air duct systems serving more than two adjacent stories.

### 7.2.2 Connecting, joining and splicing flexible ducts

The document states that all connections, joints and splices shall be made in accordance with the manufacturer's installation instructions. It also states that all tapes, mastics, and non-

metallic clamps used for field installation of flexible ducts shall be listed and labelled to Standard UL 181B - Closure Systems for Use With Flexible Air Ducts and Air Connectors.

It provides the following type of illustrative guidance about the connection, joining and splicing of flexible ducts



*Connections and Splices - Using Mastic and Fasteners*

Step 1
After desired length is determined, cut completely around and through duct with knife or scissors. Cut wire with wire cutters. Pull back jacket and insulation from core.

Step 2
Apply mastic approximately 2" [50 mm] wide uniformly around the collar of the metal fitting or over the ends of a 4" [100 mm] min. length metal sleeve. Reference data on mastic container for application rate, application thickness, cure times and handling information.

Step 3
Slide at least 2" [50 mm] of core over the fitting or sleeve ends and past the bead.

Step 4
Secure core to collar with a clamp applied past the bead. Secure cores to sleeve ends with 2 clamps applied past the beads.

Step 5
Pull jacket and insulation back over core ends. Tape jacket(s) with at least 2 wraps of duct tape. A clamp may be used in place of or in combination with the duct tape.



**NOTES:**
1. For uninsulated air ducts and air connectors, disregard references to insulation and jacket.
2. Use beaded sheet metal fittings and sleeves when using nonmetallic clamps.
3. Use mastics listed and labeled in accordance with Standard UL 181B and marked "181B-M" on container.
4. Use tapes listed and labeled in accordance with Standard UL 181B and marked "181B-FX".
5. Nonmetallic clamps shall be listed and labeled in accordance with standard UL 181B and marked "181B-C".

### 7.2.3 Typical flexible duct accessories

The document provides the following type of illustrative guidance about flexible duct accessories.

**5.1 Types**

These figures depict typical accessories but do not represent all available accessories. The designer should select and approve accessories which are acceptable for each application taking into account the inherent pressure loss characteristics of the selected accessory (Refer to ACCA Manual D and ASHRAE Fundamentals). This standard is not intended to limit the selection or the development of accessories for use with flexible duct.

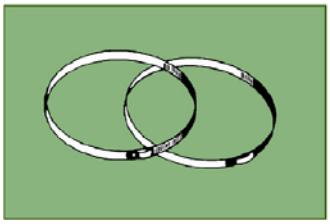


***Figure 27*** *Metal Duct Clamp*

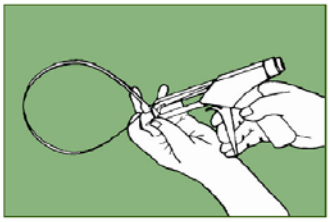


***Figure 28*** *Nonmetallic Mechanical Fastener, Shall be listed to UL181B*

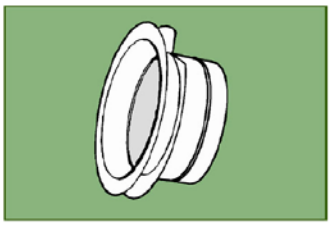


***Figure 29*** *Ductboard Collar (Spin-In)*

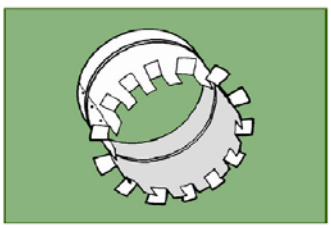


***Figure 30*** *Sheet metal Collar (Dovetail)*

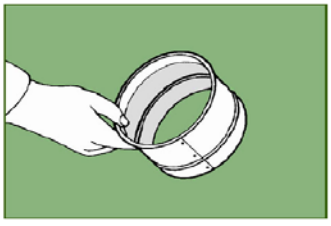


***Figure 31*** *Sheet metal Collar (Spin-In-Straight)*

## 7.1 AIR DIFFUSION COUNCIL (ADC) – FLEXIBLE AIR DUCT TEST CODE FD 72-R1

### 7.1.1 Overview of ADC flexible air duct test code FD 72-R1

This document is a comprehensive document prepared for standard testing and reporting of flexible air duct and air connector performance. It presents specific methods of testing flexible air ducts used for indoor comfort heating, ventilating and air conditioning applications.

This test code establishes the requirements for the determination and presentation of data on air friction loss, sound, leakage, heat transfer properties, and static pressure and temperature behaviour for flexible air ducting used as a means of conveying conditioned air in heating and air conditioning systems.

Requirements are established for the selection and preparation of test specimens, the test equipment and procedures to be used, the installation of test specimens, the accumulation test data, and the format for presentation of results.

## 7.2 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) 90A – STANDARD FOR THE INSTALLATION OF AIR CONDITIONING AND VENTILATING SYSTEMS

### 7.2.1 Overview NFPA 90A

This standard covers the construction, installation, operation and maintenance of systems for air conditioning and ventilating, including filters, ducts and related equipment, to protect life and property from fire, smoke and gases resulting from fire or from conditions having manifestations similar to fire.

It prescribes the minimum requirements for safety to life and property from fire, and is intended to accomplish the following:

- Restrict the spread of smoke through air duct systems within a building or into a building from the outside
- Restrict the spread of fire through air duct systems from the area of fire origin
- Maintain the fire-resistive integrity of building components affected by the installation of duct systems
- Minimise the ignition sources and combustibility of the elements of air duct systems

### 7.2.2 Air ducts

This standard states that Class 0 or Class1 rigid or flexible ducts, tested in accordance with UL 181 – Standard for safety of factory-made air ducts and air connectors, and installed in conformance within the conditions of listing, shall be permitted to be used for ducts when air temperature in the ducts does not exceed 121$^{o}$C.

It states that air ducts shall be considered to be in compliance with this requirement where constructed and installed in accordance with the ASHRAE Handbook – HVAC Systems and Equipment, and with SMACNA HVAC Duct Construction Standards – Metal and flexible and SMACNA HVAC AIR Duct Leakage Test Manual.

### 7.2.3 Air connectors

The document states that air connectors are limited-use flexible air ducts that shall not be required to conform to the requirements for air ducts, providing they meet the following requirements:

- Air connectors shall conform to the requirements for Class 0 or Class 1 connectors when tested in accordance with UL 181 – Standard for safety of factory-made air ducts and air connectors[22]
- Class 0 or Class 1 air connectors shall not be used for ducts containing air at temperatures in excess of 121°C
- Air connector runs shall not exceed 4.27m
- Air connectors shall not pass through any wall, partition or enclosure of a vertical shaft that is required to have a fire resistance rating of one hour or more
- Air connectors shall not pass through floors

## 7.3 ASHRAE HANDBOOK – HVAC SYSTEMS AND EQUIPMENT

### 7.3.1 Overview ASHRAE Handbook – HVAC systems and equipment

This document provides guidance about the design and installation of heating, ventilation and air conditioning systems covers the construction, installation, operation and maintenance of systems

### 7.3.2 Residential duct construction

The document states that supply ducts may be steel, aluminium or materials with a UL Standard 181 listing. It also states that ducts should be installed in accordance with SMACNA HVAC Duct Construction Standards – Metal and flexible.

It states that for return ducts, NFPA Standard 90B should be consulted

### 7.3.3 Commercial duct construction

The document states many building code agencies use NFPA standard 90A, which invokes UL standard 181. Ducts are classified as:

- Class 0: Air duct materials having a fire hazard classification of zero (flame spread and smoke developed)
- Class 1: Air duct materials having a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke development rating of not over 50

### 7.3.4 Flexible ducts

The document refers to SMACNA HVAC Duct Construction Standards – Metal and flexible for guidance about installation standards and a specification for joining, attaching and supporting flexible duct. It also refers to the Air Diffusion Council (ADC) flexible duct performance and installation standard.

It states that the routing, the number and sharpness of bends, and the amount of sag allowed between support joints significantly affect system performance because of the increased each introduces. It proposes that the minimum length of flexible duct needed to make connections should be used.

[22] Air duct materials are classified in UL181 as follows:

- Class 0: Air duct materials having a fire hazard classification of zero (flame spread and smoke developed)
- Class 1: Air duct materials having a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke development rating of not over 50

## 7.4 National Fire Protection Association (NFPA) 90B – Warm air heating and air conditioning systems

### 7.4.1 Overview NFPA 90B

This standard prescribes minimum requirements for safety to life and property. It applies to all systems for the movement of environmental air in structures that:

- Serve one or two-family dwellings
- Serve spaces not exceeding 708m$^3$ in volume in any occupancy

### 7.4.2 Duct materials

This standard states that supply ducts shall be:

- Class 0 or Class 1 rigid or flexible ducts when tested in accordance with UL 181 – Standard for safety of factory-made air ducts and air connectors[23]

or

- Sheet metal having prescribed nominal thicknesses

### 7.4.3 Air connectors

The document states that air connectors are limited-use flexible air ducts that shall not be required to conform to the requirements for air ducts, providing they meet the following requirements:

- Air connectors shall conform to the requirements for Class 0 or Class 1 connectors when tested in accordance with UL 181 – Standard for safety of factory-made air ducts and air connectors
- Class 0 or Class 1 air connectors shall not be used for ducts containing air at temperatures in excess of 121$^o$C
- Air connector runs shall not exceed 4.3m
- Air connectors shall not pass through any wall, partition or enclosure of a vertical shaft that is required to have a fire resistance rating of one hour or more
- Air connectors shall not pass through floors

## 7.5 Underwriters Laboratory (UL) 181 – Factory made air ducts and air connectors

### 7.5.1 Overview UL181

This document applies to materials for the fabrication of air duct and air connector systems for use in accordance with National Fire Protection Association (NFPA) standards 90A and 90B.

The air ducts and air connectors covered by the document's requirements include preformed lengths of flexible or rigid ducts and pre-formed flexible air connectors.

[23] Air duct materials are classified in UL181 as follows:

- Class 0: Air duct materials having a fire hazard classification of zero (flame spread and smoke developed)
- Class 1: Air duct materials having a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke development rating of not over 50

### 7.5.2 Duct performance requirements

This document states that air ducts and air connectors should be classified as follows:

- Class 0: Air duct materials having a fire hazard classification of zero (flame spread and smoke developed)
- Class 1: Air duct materials having a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke development rating of not over 50

# 8 MANUFACTURERS' TECHNICAL LITERATURE

The content of this chapter has been compiled by referencing technical product information produced by the following companies;

- Lindab
- Senior Hargreaves
- Hotchkiss Air Supply
- National Ventilation

## 8.1 APPROVALS FOR DIFFERENT PRODUCTS

The following table summarises the approvals that are stated in the product literature for flexible ductwork products supplied by different companies

| Product description | Description of product approval |
|---|---|
| Company A | |
| Product 1: A pure aluminium duct of laminated construction | BS 476: parts, 6, 7 and 20 |
| Product 2: PVC coated glass fibre with a spiral wire | Class E according to BS EN 13501-1. French Class M1. BS EN 13180 |
| Product 3: A semi-flexible aluminium duct | Not flammable in accordance with DIN 4102 class A1 |
| Product 4: A semi-flexible galvanized steel duct | Not flammable in accordance with DIN 4102 class A1 |
| Product 5: An aluminium/polyester duct with spiral wire | BS 476: parts, 5, 6, 7 and 20. BS EN 13180. French Class M1 |
| | |
| Company B | |
| Product 1: An aluminium/polyester duct with spiral wire | BS 476: parts, 6, 7 and 20. Class B-s1, d0 according to BS EN 13501-1. French Class M1. DIN 4102 class B2. BS EN 13180 |
| Product 2: An aluminium/polyester/copolymer duct with spiral wire | BS 476: parts, 6, 7 and 20. DIN 4102 class B2. BS EN 13180 |
| Product 3: An aluminium inner duct, insulated with glass wool and with a glass fibre strengthened outer jacket | BS 476: parts, 6, 7 and 20. Class B-s1, d0 according to BS EN 13501-1. French Class M1. DIN 4102 class B2. BS EN 13180 |
| Product 4: A perforated aluminium laminate inner duct, insulated with glass wool and with a glass fibre strengthened outer jacket | BS 476: parts, 6, 7 and 20. DIN 4102 class B2. French Class M1. BS EN 13180 |
| Product 5: A corrugated aluminium duct | BS 476: parts, 6, 7 and 20. Class A1 according to BS EN 13501-1. DIN 4102 class A1. French Class M0. BS EN 13180 |
| | |
| Company C | |
| Product 1: An aluminium/polyester/fibreglass acoustic duct | BS 476: parts, 6, 7 and 20. |
| Product 2: A corrugated aluminium duct | BS 476: parts, 6, 7 and 8. |
| | |
| Company D | |
| Product 1: A semi-rigid aluminium duct | BS 476: parts, 6, 7 and 6. |
| Product 2: An aluminium/polyester/fibreglass acoustic duct | BS 476: parts, 6, 7 and 20. |
| Product 3: An aluminium/polyester duct with spiral wire | BS 476: parts, 6, 7 and 20. |
| Product 4: An aluminium/polyester duct with spiral wire and fibreglass insulation | |