CI/SfB (57.9) Ih (A3u)

DW/142

Specification for sheet metal ductwork

ADDENDUM A

Low, medium and high pressure / velocity air systems

HEATING AND VENTILATING CONTRACTORS' ASSOCIATION
1988

(64)

"CONTROLLED"

HEATING AND VENTILATING HVCA CONTRACTORS' ASSOCIATION

ADDENDUM A

DW/142

Specification for sheet metal ductwork

Low, medium and high pressure/velocity air systems 1988

ISBN 0 903783 04 5

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Contents

Introduction

DW/142 – Specification for Sheet Metal Ductwork – was prepared by a Drafting Panel representing a wide range of interests – ductwork contractors, general mechanical services contractors, consulting engineers, quantity surveyors, research associations, hospital authorities, equipment manufacturers and others.

Since publication in November 1982 the HVCA's Duct Work Group's Technical Sub-Committee have met on a regular basis to review the progress and changes in technology in the Industry. As a result it was agreed that certain areas of the specification required amendment.

Accordingly the Sub-committee was authorised to produce an addendum which resulted in the publication of this document.

DW/142 is now always to be read in conjunction with this document and to that end you are advised to fix the large gummed label (supplied with this document) to the front cover of DW/142 to remind users of the existence of this addendum. The smaller gummed labels are supplied for fixing to the individual pages where amendments have been found to be necessary.

ACKNOWLEDGEMENTS

The HVCA records its appreciation and thanks to the members of the Duct Work Group's Technical Sub-Committee who contributed of their knowledge and experience in the production of this document.

The members of the Duct Work Group's Technical Sub-Committee were:-

A Wright *(Chairman)*
K H Elphick
R D Hill
H N Hobbs
R J King
J E Murray
E Poppleton
J Strachan

K Angood *(Technical Consultant)*
R J Miller *(Secretary, Duct Work Group)*

This addendum contains amendments to DW/142, relating to Pages 2, 12, 14, 16, 17, 20, 21, 24, 26, 27, 29, 32, 33, 35, 37, 39, 41, 42, 44, 47, 48, 50, 52, 54, 55, 56, 57, 58, 59, 60, 61, 65, 67, 68, 76, 78, 82, 86, 88, 90, 91, and 92.

The amendments are as follows:

Page 2:-
Add to **2.1** after the words "........... standard practice". the words "Designers shall stipulate their requirements for periodic internal cleaning of ductwork and of the consequent need for adequate access for specialist cleaning equipment".

Page 12
Delete in its entirety Note 7 and insert in lieu:-
"(7) Manufacturing techniques are continually subject to change and improvements and in respect of proprietary devices this specification does not preclude their use if they can be shown to the designer to be equally satisfactory."

Page 14
(a) Delete in its entirety section **7.1** and insert in lieu:-
"**7.1 Applicability**
This specification applies to ductwork made from materials as defined below, or equal. Minimum sheet thickness is to be taken as a nominal thickness within the tolerances quoted by the British Steel Corporation. ('sheet' is to be understood to include coil).

See appendix L for a summary of BS2989: 1982."

(b) Delete in its entirety section **7.2.1** and insert in lieu:-

"**7.2.1** Ductwork will normally be made from hot-dip galvanised sheet to BS2989, Grade Z2 coating type G275 or equal. If this is not available, alternative types are:"

(c) At the bottom of the page add:-

"NOTE "DUCTWORK LAYOUT DRAWINGS SCALES"
It is common practice and cost effective for ductwork manufacturers to utilise their approved ductwork layout drawing as the basis of their manufacturing/installation information by adding the necessary details to the same drawing. Scales of 1:50 or smaller may preclude this practice. Therefore larger scales might be more appropriate. The final choice of scales should be left to the ductwork contractor."

Page 16
(a) Add to the end of section **9.6.1**:-
"NOTE: See DW/TM1 (1987) re - new products"

(b) Add to the end of section **9.6.3**

"Particular attention should be made to the sealing of corner pieces and reference should be made to the manufacturer's assembly and sealing instructions"

(c) Add the following section **9.6.4**

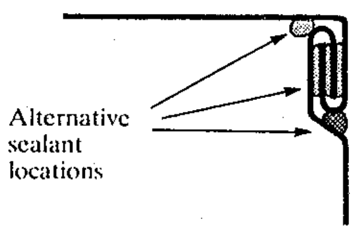
"**9.6.4 Adjustable/slip joints**

In order to accommodate manufacturing/building tolerances, site modifications etc, it is accepted practice to use an adjustable joint as illustrated in Fig 19a of this addendum.

Any such joint must be adjacent to a stiffening frame, as illustrated, or a cross joint and be fastened and sealed in accordance with the instructions for socket and spigot joints."

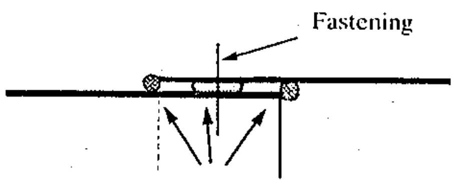
Page 17
(a) on figure 2 an additional sealant location to be added and the figure to be as indicated below:-

Fig. 2 Grooved corner seam



(b) on figure 7 additional sealant locations to be added and the figure to be as indicated below:-

Fig. 7 Lap seam



Note. – This seam is acceptable for use on low- and medium-pressure ducts only

Page 20
In column 7 of Table 7 the bottom three dimensions of 1250 to be deleted and 1000 inserted in each case and the table to be as indicated below:-

Constructional Requirements – Rectangular Ducts
Table 7 HIGH PRESSURE (up to 2000 Pa)

Dimensions in mm

Maximum duct size (longer side) or → length of stiffeners			400	600	800	1000	1250	1600	2000	2500
Minimum sheet thickness →			0.8				1.0		1.2	
Type	Rating	Sheet	Maximum spacing between joints and stiffeners							
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Socket & Spigot Joints	A1	PS/SS	3000							
	A2	PS/SS	3000							
	A3	PS/SS	3000							
Flanged Joints & Stiffeners	J1/S1	PS/SS	3000	625						
	J2/S2	PS/SS	3000	1250	800					
	J3/S3	PS/SS	3000	1250	1250	800				
	J4/S4	PS/SS	3000	1250	1250	1000	800			
	J5/S5	PS/SS	3000	1250	1250	1000	800	800	625	
	J6/S6	PS/SS	3000	1250	1250	1000	800	800	800	625

Page 21
(a) in column 3 of Table 10 add an asterisk to the bottom dimension 150. The dimension to be as indicated below:-

"150*"

(b) in column 6 of Table 10 add two in number asterisks to the bottom dimension 150. The dimension to be as indicated below:-

"150**"

(c) to the bottom of the page add the following two notes:-

"*NOTE: In addition to dimpling, one of the other types of fastening must be used at each end

**NOTE: In addition to dimpling, one of the other types of fastening must be used at 450mm centres and in all cases not less than one per side."

Page 24
In the script at the top right of the page the words "(Page 19)" to be deleted and the words "(page 21)" to be inserted in lieu. The complete wording to be as indicated below:

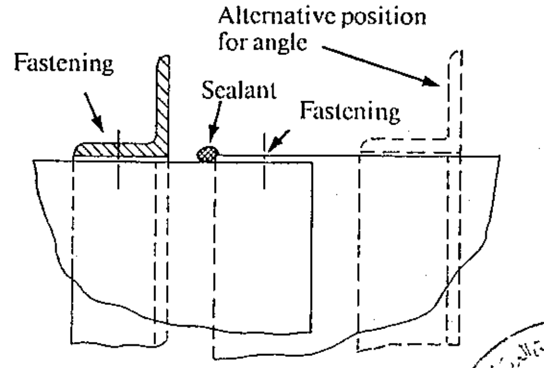
"For permitted fastenings (types and spacing) see Table 10 (Page 21)"

Page 26
From the script on Fig. 16 delete in its entirety the last paragraph:-
"With high-pressure ductwork spigot corners shall be welded and lap seam section sealed"

Nothing is to be added in lieu.

Page 27
Add the figure illustrated below which relates to the addition of clause 9.6.4 which is covered on Page 6 of this addendum.

Fig. 19a Adjustable/Slip Joint (see 9.6.4)



Page 29

(a) in the script at the bottom right of Fig. 25 delete "S" and insert "C" in lieu. the figure to be as indicated below:-

(b) in the script at the bottom right of Fig. 26 delete "C" and insert "S" in lieu. The figure to be as indicated below:

(c) On Fig. 27 indication arrows to be inserted from the script at bottom left and from the script at top right. The figure to be as indicated below:-

Fig. 25 'C' cleat with grooved seam

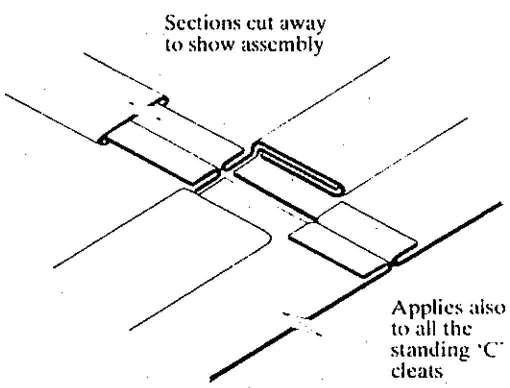


Fig. 26 'S' cleat with grooved seam

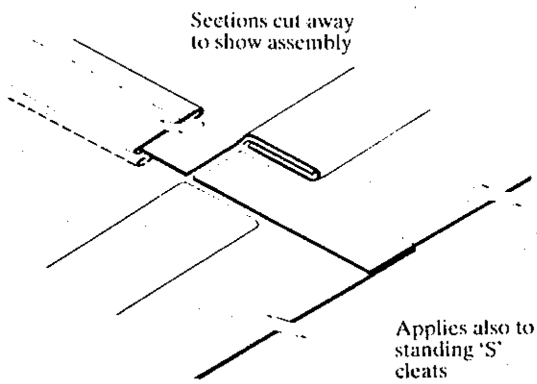
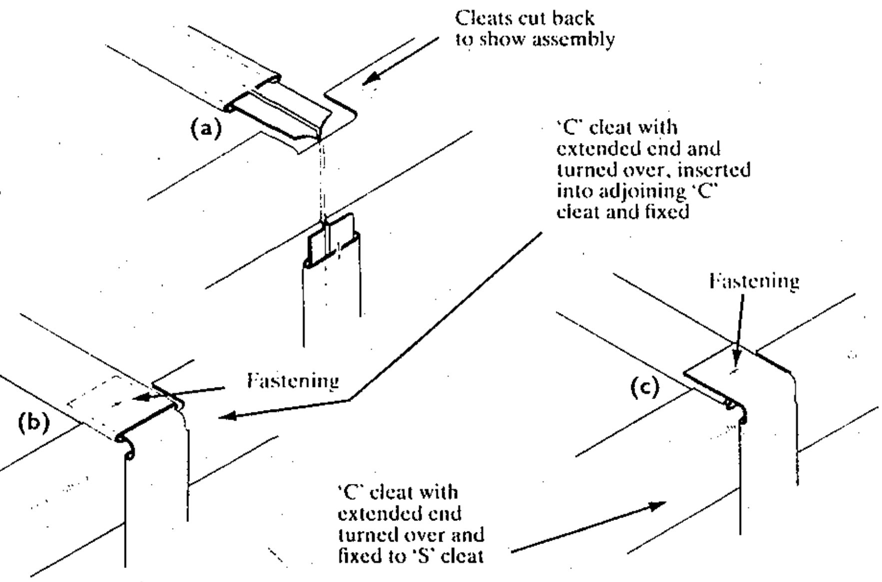


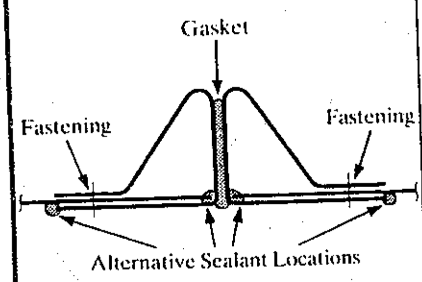
Fig. 27 'S' and 'C' cleat with Pittsburgh lock, grooved corner or button punch snap lock seam

Notes:
1. With 'C' cleats on all four sides, three corners are as (b); the fourth overlapped as illustrated for 'S' cleat (c).
2. (a) and (c) apply also to all the standing 'S' cleats

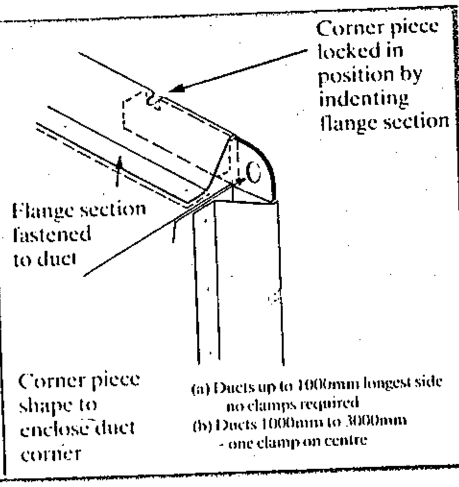


Page 32
Delete in its entirety fig.40 and insert in lieu new Fig. 40 as indicated below:-

Fig. 40 Slide-on flange with integral sealant

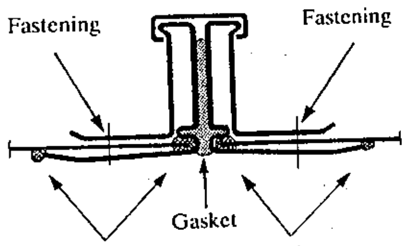


21 × 0.9	J2	Low Medium
32 × 0.9	J3	Low Medium
42 × 1.25	J4	Low Medium High
42 × 1.25	J5*	Low Medium High



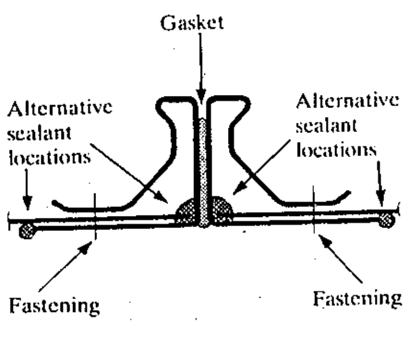
Page 33
(a) Delete in its entirety Fig. 41 and insert in lieu new Fig. 41 as indicated below:-

Fig. 41 Slide-on flange



(b) Delete in its entirety Fig. 42 and insert in lieu new Fig. 42 as indicated below:-

Fig. 42 Slide-on flange



(c) In the dimensions column of Fig. 43 delete the bottom dimension "25 × 1.0"
(d) In the rating column of Fig 43 delete the bottom rating "*J4"
(e) Add to the note "*With central tie bar" at the bottom of the page "(See para **2, 9.7.3**)".

Page 35
(a) Add to the beginning of **11.4** the following:-

"If the leading edge of the splitters exceeds 1250mm fit central tie bars at both ends to support the splitters. Leading and trailing edges of splitters must be edged and flattened and be parallel to the duct axis."

(b) Delete in its entirety section **11.7.3** and insert in lieu:-

"**11.7.3** Welding

As an alternative to the methods described in **11.7.1** and **11.7.2**, branch connections may be continuously welded or spot welded and will be governed by the sheet thickness, the branch size and the need to ensure air tightness."

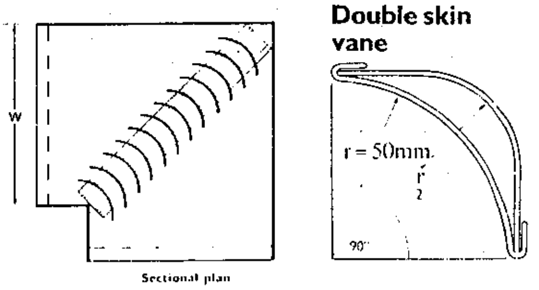
Page 37

(a) In the script, at the top centre of the page, delete the words "page 33" and insert in lieu the words "page 35" The complete wording to be as below:-

"For sealing requirements, see section **11.10** (page 35)"

(b) Delete in its entirety "Table 12" and insert in lieu "Maximum distance between centres of turning vanes should not exceed 60mm"

The amendment to be as below:-



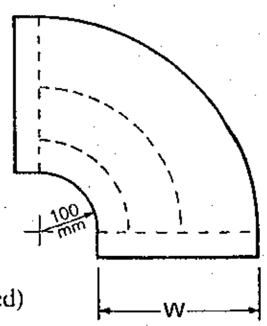
Maximum distance between centres of turning vanes should not exceed 60mm.

(c) On fig. 59 delete the reference to Fig 52(a). The complete wording to be as indicated below:-

"Splitters in accordance with Fig. 52(b)"

(d) Delete Fig 52(b) and the note and table under Fig. 52(b) and insert in lieu the following Fig 52(b) with the accompanying table and note.

Fig. 52(b) Short radius with Splitters (Splitters not applicable to bends under 45°)



(2 Splitter bend illustrated)

EXAMPLE OF A SPLITTERED BEND WITH THE MINIMUM THROAT RAD OF 100mm

W	No of Splitters	Width of each air passage as a fraction of 'W' (inner passage shown first)
Up to 300	0	W (i.e. Fig 52a)
Over 300 up to 500	1	⅓ W ⅔ W
Over 500 up to 1000	2	⅙ W ⅓ W ½ W
Over 1000	3	1/12 W ⅙ W ¼ W ½ W

NB Short radius bends of varying radius may be used either with the same ratios tabled above or with each splitter positioned so that r/w ratio for any air passage is preferably above 1.5 with a minimum of 1.25 [r = centre line radius of passage and W = width of passage

Page 39

(a) To the note under Table 13 add "(see Appendix K, note 6)"

(b) Delete in its entirety section **13.3.2** and insert in lieu:–

"**13.3.2** Straight-seamed ducts

The longitudinal seam for straight-seamed circular ducts shall be either the grooved seam (Fig. 74), continued to the extreme end of the duct and sealed during manufacture, or a continuous butt lap weld or spot weld and sealed lap joint (at 30mm centres) provided this gives a smooth internal finish."

Page 41

(a) Delete in its entirety the first line (under the heading) of **13.5.5.** and insert in lieu:-

"The suitability of continuous welding or spot welding for sheet to sheet"

(b) Table 16 to be amended as below:-

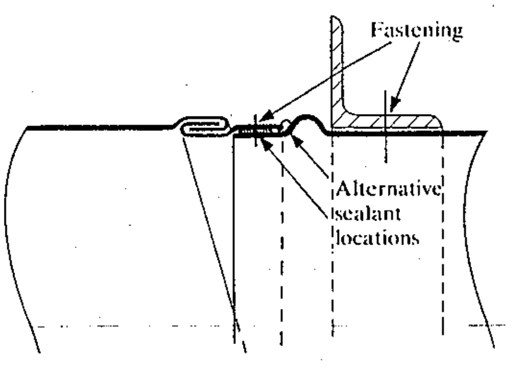
Type of Fastening	Sheet to Sheet		Sheet to section (cross joint flanges and intermediate stiffeners)	
	Lap Joints	Cross Joints	Spirally wound	Straight seamed
1	2	2A	3	4
			mm	mm
Mechanically Closed Rivets	60mm centres	150mm centres	150	150
Bolts and nuts	–	–	300	300
Lock Bolts	–	–	300	300
Spot Welds	30mm centres	30mm centres	150	150

Page 42

On Fig. 77 delete reference to the alternative position for angle.

The amended figure to be as below:-

Fig. 77 Angle reinforced socket and spigot with connector

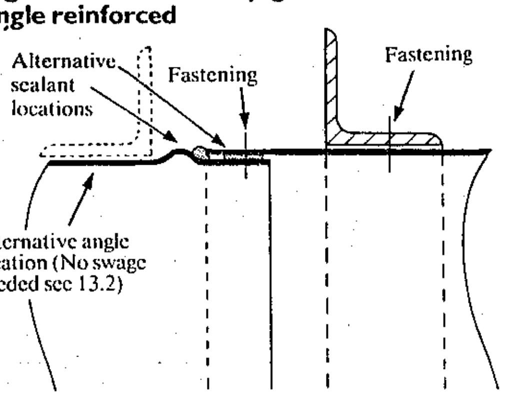


Page 44

(a) On Fig. 84 add an alternative angle location to the left hand side of the sketch and add the words "Alternative angle location (No swage needed see **13.2**)"

The amended figure to be as below:-

Fig. 84 Socket and spigot – angle reinforced



(b) On Fig. 85 add the words "Swage not necessary" under the words "Fig. 85 Angle Flanged".

Page 47

(a) At the top of the page at the end of the second line delete in the brackets the words "page 39" and insert in lieu the words "page 41"

(b) in the last line of the script under Fig. 87 delete the words "four-segment bend" and insert in lieu the words "four-section bend"

(c) add to the script under Fig. 88 the words "(also acceptable as a three-section bend)"

(d) add to the end of the note under Fig. 90 the words "unless an angle flange is fitted"

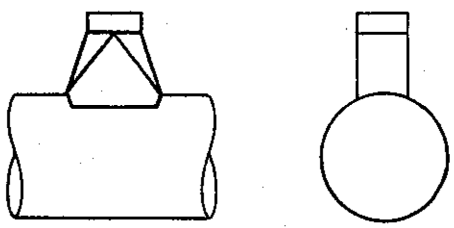
(e) in the last line of the script under Fig. 93 delete the words "Figs 91 and 92" and insert in lieu the words "Fig. 91 or 92"

Page 48

(a) Fig. 96 to be re-numbered 96a. (illustration stays the same).

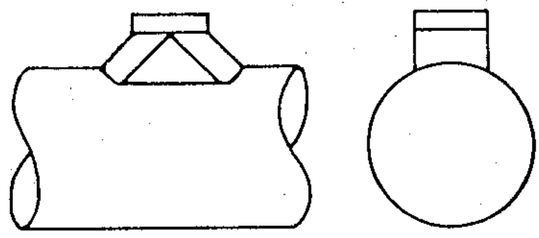
(b) add new Figure 96b:-

Fig. 96b
Conical



(c) Delete Fig 97 and insert in lieu new fig. 97 indicated below:-

Fig. 97
Bell mouth



Page 50

In column 1 of Table 21, under Fig. 111, delete the words "100mm centres" and insert in lieu the words "1000mm centres"

Page 52

Delete in its entirety the first line of 16.3 and insert in lieu the words "Cross joints shall be as Figs 75, 76, 77, 78 or 79 or such"

Page 54

(a) At the top of the page at the end of the second line delete in the brackets the words "page 50" and insert in lieu the words "page 52"

(b) under the last line of the script under Fig. 121 insert the words "(also acceptable as a four-section bend)"

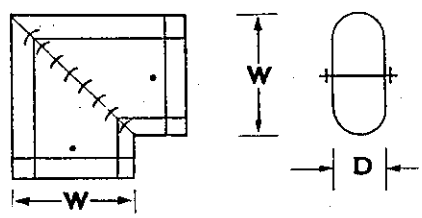
(c) under the last line of the script under Fig. 122 insert the words "(also acceptable as a three-section bend)"

(d) on Fig. 122 delete "1½D" and insert in lieu "1½D or 1D"

(e) on Fig. 124 delete "1½D" and insert in lieu "1½D or 1D"

(f) Figure 127 to be re-drawn as indicated below:-

Fig. 127
Square (hard)



(g) at the bottom of the page add the following words:-

"NOTE: Tie rods (applicable to all sketches) are to be fitted in accordance with the pattern for straights (See tables 21 and 22)"

Pages 55,56,57,58,59, 60 and 61
ALTHOUGH FEW CHANGES HAVE BEEN MADE TO PART SIX OF DW/142, IT IS, FOR CLARITY, REPRODUCED IN ITS AMENDED FORM AS FOLLOWS:-

Delete pages 55, 56, 57, 58, 59, 60 and 61 and insert in lieu, the following:-

19 GENERAL

19.1 Principles Adopted

Supports are an essential part of the ductwork system, and their supply and installation are normally the responsibility of the ductwork contractor. The choice between the available methods of fixing will depend on the type of building structure and on any limitations imposed by the structural design. Further, unless the designer has specified his requirements in detail, the load to be carried shall be understood to be limited to the ductwork and its associated insulation.

It is not practicable to deal here with the full range of supports available, which increasingly includes proprietary types, so in this section various methods of support are dealt with in principle under the three elements of:

(1)the attachment to the structure;
(2)the hanger itself; and
(3)the duct bearing member

with illustrations of those most commonly used. Special attention has been given to the treatment of supports for insulated ducts, with and without vapour sealing.

Supports for ductwork external to the building have been excluded, as these are individually designed to suit the circumstances, and also may be required to meet local authority standards. For the same reasons, floor supports have not been dealt with.

With a proprietary device, it will, unless the designer has specified his requirements in detail, be the responsibility of the ductwork installer to ensure that it meets requirements, with a sufficient margin of overload; and that it is installed in accordance with the manufacturer's recommendations.

The absence of any method of device from this specification does not preclude its use if it can be demonstrated that it is suitable for the duty assigned to it, with a sufficient margin of safety against overload; and this will be the responsibility of the ductwork installer, unless the designer has specified his requirements in detail.

19.2 Fixing to Building Structure

The fixing to the building structure should be of a strength and durability compatible with those of the ductwork support attached to it. A fixing to concrete or brickwork must be made in such a way that it cannot loosen or pull out through normal stressing or through normal changes in the building structure.

19.3 Horizontal Ductwork

19.3.1 Attachment to structure

This section has been deleted as the references in DW/142 to certain types of structural attachments could be restrictive in view of the extensive variety of methods that have been made available since DW/142 was first published.

19.3.2 The Hanger Itself

The hanger itself is usually mild steel plain rod or studding or flat strap, pre-treated by, e.g. hot-dip galvanising, Sherardizing, electro-deposited zinc plating or by some other accepted anti-corrosion treatment. Other materials, such as stranded wire, may also be acceptable.

Projection of a rod or studding hanger through the bottom bearer should, where practicable, not exceed twice the thickness of the securing nut.

Provided the integrity of the ductwork is maintained, hangers may be attached to the corners of the flanges as an alternative to the use of a bottom bearer.

With proprietary devices manufacturers' recommendations for use should be followed.

19.3.3 The Duct Bearing Member

The choice of the lower support will be dictated by the actual duct section.

19.3.3.1 Rectangular Ducts

Table 24A of this addendum gives minimum dimensions for the hangers and for angle, channel and profile sections. The angle is shown in Fig. 142, the channel in Fig 143 and the profile sections in Figs. 144 and 145.

Typical arrangements of bottom bearer supports for plain, insulated and vapour-sealed ducts are shown in Figs. 5, 6 and 7 of this addendum.

19.3.3.2 Circular Ducts

Table 24A of this addendum gives minimum dimensions for the hanger and for the brackets – as illustrated in figs 1 to 4 of this Addendum.

19.3.3.3 Flat Oval Ducts

Table 24A of this addendum gives minimum dimensions for the hanger; and for the bearer, depending on whether the flat side of the duct is horizontal or vertical.

Typical arrangements for flat oval duct supports are shown in Figs. 5, 8 and 9 of this addendum.

19.4 Vertical Ducts

The design of supports for vertical ducts is dictated by site conditions, and they are often located to coincide with the individual floor slabs, subject to a maximum spacing of 4 metres.

Vertical ducts should be supported from the stiffening angle or the angle frame, or by separate supporting angles fixed to the duct.

A typical method of supporting vertical rectangular ducts is shown in Fig. 159 and for circular ducts in Fig. 160. The same methods are applicable to vertical flat oval ducts.

19.5 Heavy loadings

For ducts larger than those covered by Table 24A, or where heavy equipment, mechanical services, ceilings or other additional load is to be applied to the ductwork, supports shall be designed to suit the conditions.

19.6 Insulated Ducts

Where ductwork is required to be insulated, this must be clearly specified, so that hangers are spaced to provide clearance for the insulation. Otherwise, supports may be as for uninsulated ductwork. Where fire regulations apply, approval of the relevant authority may be needed.

19.6.1 Insulated ducts with vapour sealing

Where the temperature of the air within the duct is at any time low enough to promote moisture penetration through the lagging and cause condensation on the exterior surface of the duct, vapour sealing may be called for, and in this case the most important requirement is to limit penetration of the seal.

The extent of any vapour sealing of ductwork, and the method to be used, must be clearly specified in advance, as follows:

Method 1

Where the risk of damage due to condensation is slight, the vapour seal can be applied to the insulated duct and made good round the supports to achieve an acceptable level of proofing as shown in figs. 1 to 9. of this addendum.

Method 2

Where it is essential to keep penetration of the vapour seal to a minimum, supports should be external to the insulation, as shown in Figs. 1 to 9 of this addendum.

The insulation and vapour barrier should be abutted to the insulator incorporated with the duct support. This insulator shall be non-hygroscopic and shall be capable of carrying the imposed load without significant compressions. Typical materials are hardwood or treated softwood (in separate block form for circular ducts); GRP (glass-reinforced plastics); and hard rubber compounds. Some proprietary systems of support for vapour-sealed ducts are available.

19.6.2 Heat Transfer

It is not normally necessary to make special arrangements for the limitation of heat transfer via the duct supports. However, there may be special cases where the temperature difference justifies a heat barrier to conserve heat or to prevent condensation.

Table 24A (Suspersedes Tables 24, 25 and 26 in DW/142)
Supports for Horizontal Ducts – Rectangular, Flat Oval and Circular

DUCT SIZES			DROP ROD DIAM	HANGERS			BEARERS					SPACINGS	
				FLAT STRAPS			STIRRUPS			ANGLES	Roll formed channel section profile W H		
RECT	F'OVAL	CIRC		RECT	F'OVAL	CIRC	RECT	F'OVAL	CIRC	RECT & F'OVAL		RECT	F'OVAL CIRC
longer side	major axis	diam		Fig 7	Fig 9	Figs 1,2,4	Fig 6	Fig 8	Fig 3	Fig 5	Fig 5		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
400	400	315	6	25 × 0.8 plain or perf	25 × 0.8 plain or perf	25 × 0.8 plain or perf	25 × 3	25 × 3	25 × 3	25 × 25 × 1.6	H W 20 × 25 × 1.5	3000	3000
600	605	457	8	30 × 4	25 × 3	25 × 3	30 × 4	30 × 4	30 × 4	25 × 25 × 3	25 × 25 × 1.5	3000	3000
1000	1000	813	8	N/A	30 × 4	30 × 4	N/A	N/A	30 × 4	30 × 30 × 3	30 × 25 × 1.5	3000	3000
1500	1510	1120	10	N/A	N/A	40 × 5	N/A	N/A	40 × 5	40 × 40 × 3	40 × 25 × 1.5	2500	3000
2000	2000	1525	10	N/A	N/A	40 × 5	N/A	N/A	40 × 5	50 × 50 × 5	40 × 25 × 1.5	2500	3000
3000	N/A	2000	12	N/A	N/A	50 × 6	N/A	N/A	50 × 6	TO BE AGREED WITH DESIGNER			

Notes to Table 24A

(1)The dimensions included in Table 24A are to be regarded as minima.

(2)The maximum spacings set out in Table 24A are related solely to duct weight considerations. Closer spacings may be required by reason of the limitations of the building structure or to achieve the necessary duct rigidity.

(3)Rolled steel channels may be used as bearing members provided they meet the design characteristics of the bearing members tabled above.

DW 142 ADDENDUM 'A'	**Arrangement of Bearers and Hangers** (to be read in conjunction with Table 24A) (which lists material sizes relative to duct sizes)	THESE SKETCHES SUPERSEDE DW142 FIGURES 146-158 INCLUSIVE

KEY

- Attachment to structure
- Drop Rod or Studding
- Flat Bar
- Angle or Channel
- Outline of Insulation (if applicable)
- Insulator entrapped between support bearer and duct skin

Limits refer to actual duct sizes – insulation is additional

Insulation Options Figs. 1-4

Either un-insulated ducts or insulated ducts requiring a method 1 vapour seal

Insulated ducts requiring a method 2 vapour seal.

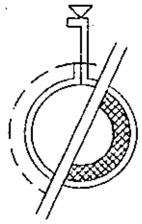
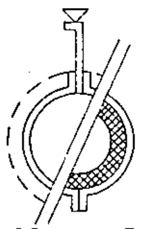


Fig 1 Wrap-Round Hanger Limit: 315 DIA



Limit: 315 DIA

Fig 2 Flat Strap Hanger & Split Clips

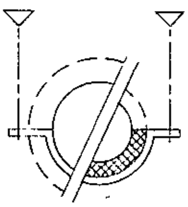


Fig 3 Stirrup Limit: 2000 DIA

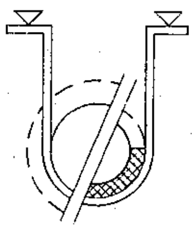
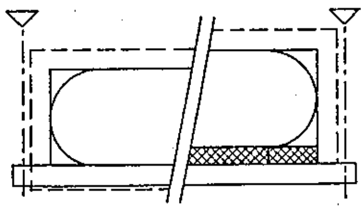


Fig 4 Flat Strap Hanger Limit: 2000 DIA

Insulation Options Figs. 5-9

Either un-insulated ducts or insulated ducts requiring a method 1 vapour seal

Insulated ducts requiring a method 2 vapour seal.



Insulator projects to duct end on rect but only to the extent of the 'flat' on the flat oval

Fig 5 Rolled or Profiled Bearer Limit: NONE

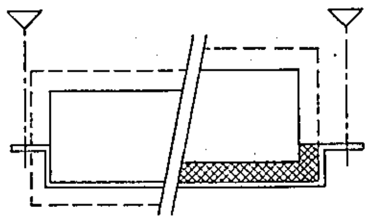


Fig 6 Stirrup Limit: 600

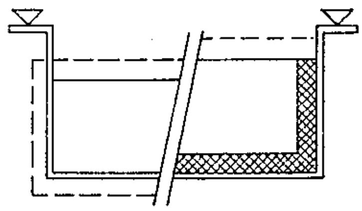


Fig 7 Flat Strap Hanger Limit: 600

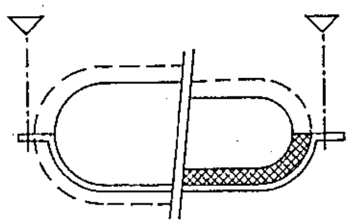


Fig 8 Stirrup Limit: 605

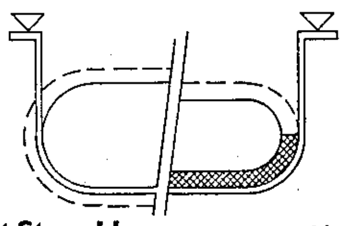


Fig 9 Flat Strap Hanger Limit: 1000

Arrangement of bearers and hangers

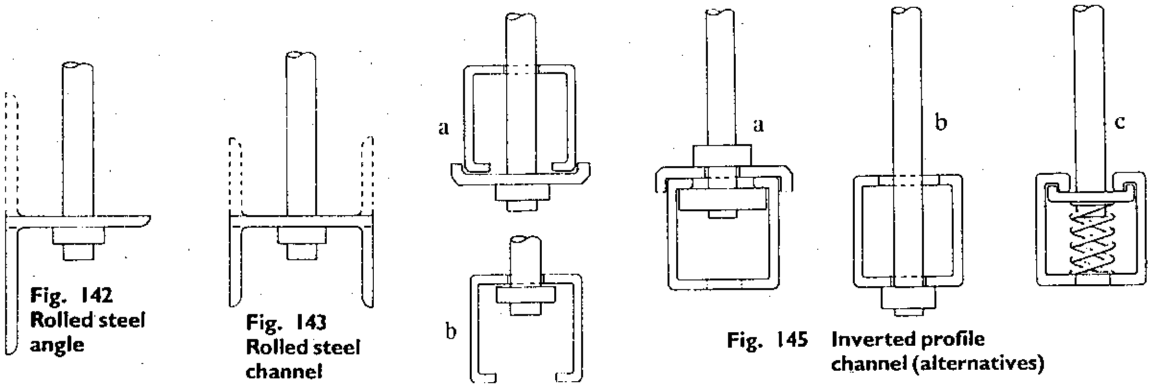


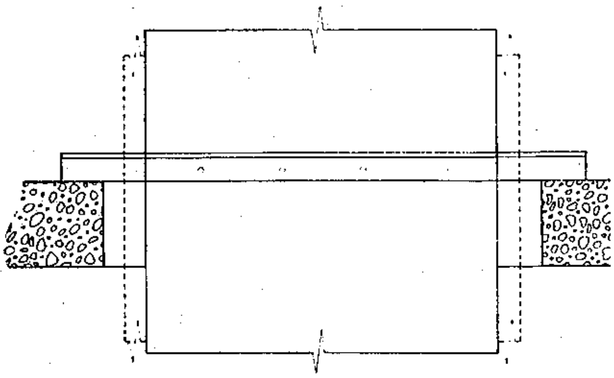
Fig. 142 Rolled steel angle

Fig. 143 Rolled steel channel

Fig. 144 Profile channel (alternatives)

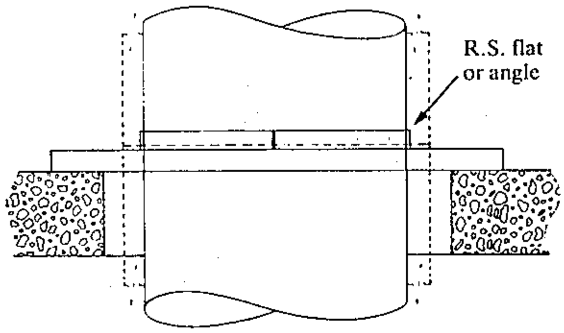
Fig. 145 Inverted profile channel (alternatives)

Fig. 159 Vertical rectangular ducts



Plain or insulated. Can be vapour-sealed to Method 1. Vapour-sealing to Method 2 is not practical with vertical duct supports.

Fig. 160 Vertical circular ducts



Plain or insulated. Can be vapour-sealed to Method 1. Vapour-sealing to Method 2 is not practical with vertical duct supports.

Page 65

(a) In the third paragraph of 22.3.1 delete the first ten words **"The blades shall be securely bolted to plated steel spindles" and insert in lieu the words "The blades shall be securely fixed to corrosion resistant spindles."**

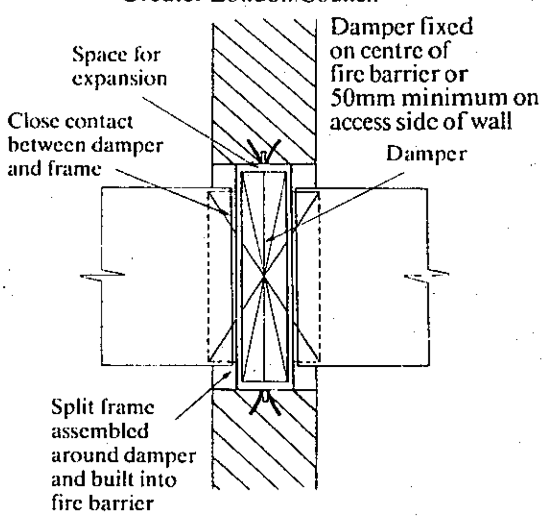
(b) In 22.3.3 delete the full stop at the end of the last sentence and add "with regard to functionality and type i.e. **22.1** and **22.2** above."

Page 67

On fig. 165 a note "Damper fixed on centre of fire barrier or 50mm minimum on access side of wall" with indicating lines is to be added as shown below:-

Fig. 165 Standard approved method of framing applicable to Fig. 164

This design was developed in collaboration by HVCA and the HEVAC Association and is approved by the Greater London Council



Page 68

In 26.4 delete from the end of the last sentence "3mm thick" and insert in lieu "2mm thick"

Page 76

At the bottom of the page on the penultimate line, after the word "EUROVENT" insert the following "[See Appendix K re-Class D (Note K8)]"

Page 78

After the last word "page" in B10 add the number "79". B10 to read as indicated below:-

"B10 Air Leakage Test Sheet

A specimen of a suitable Test Sheet is given on page 79."

Page 82 APPENDIX E

The following section E3 to be added – to read as:-

"E.3 In preparation for testing or to prevent ingress of dirt/dust into system care should be taken to ensure that all solvent vapours are dispersed from ducts before blanking off occurs."

Page 86

H.3.1 to be deleted and the following inserted in lieu:-

"H.3.1 Pre-coated steel is available in sheet or coil form. The maximum available width can vary according to the steel thickness required. Availability varies according to type of substrate and coating, so prospective purchasers should query the sizes available for the specific type required"

H.4.1 to be deleted and the following inserted in lieu

"H.4.1 Pre-coated steel is widely available but it should be noted that minimum order quantities may apply."

Page 88

The heading "APPENDIX L – SUMMARY OF BS 2989: 1975" to be deleted and the following inserted in lieu:-

"APPENDIX ' – SUMMARY OF BS 2989: 1982"

Page 90

Delete the 5th to 8th lines towards the bottom of the second column and insert in lieu:-

"HEVAC ASSOCIATION
Sterling House, 6 Furlong Road, Bourne End, Bucks. SL8 5DG. (PHONE: 062 85 31186, FAX: 0628 810423)"

Page 91

(a) In column 1 delete lines 28 to 30 and insert in lieu:-

"BRITISH STANDARDS INSTITUTION

Sales Department, Linford Wood, Milton Keynes, MK14 6LE. (PHONE: 0908 221166, TELEX 825777, FAX: 0908 320856)."

(b) Delete the 43rd to 47th lines towards the bottom of the second column and insert in lieu:-

"DEPARTMENT OF THE ENVIRONMENT (Property Service Agency)
Directorate of Mechanical & Electrical Services (DMEES), Apollo House, 36 Wellesly Rd, Croydon, CR9 3WR. (PHONE: 01 686 5622)"

(c) add the following to the bottom of the page:-

"SINCE ITS PUBLICATION OTHER ADDRESSES CONTAINED WITHIN DW/142 MAY HAVE CHANGED AND SOME PUBLICATIONS MAY HAVE BEEN SUPERSEDED"

Page 92
Add the following note above the table on galvanized sheet thicknesses:-

"NOTE

The sheet thickness tabled below are all subject to tolerances in accordance with BS2989 (1982) and are dependent on coating type (see Appendix L.3) and nominal sheet widths. Tolerances relative to sheet widths and lengths are also included in BS2989 (1982)".

CI/SfB (57.9) Ih (A3u)

DW/142

Specification for sheet metal ductwork

Low, medium and high pressure / velocity air systems

HEATING AND VENTILATING CONTRACTORS' ASSOCIATION

1982

Important notes

(1) Even where a ductwork job specification calls for the system to be wholly in accordance with DW/142, it will still be necessary for the designer, in addition to providing drawings showing details and dimensions of the ductwork, to identify his particular requirements.

The Technical Information to be Provided by Designer is therefore set out in detail on the reverse of this flap.

(2) **While it shall be mandatory for high-pressure ductwork (as defined in this specification) to be tested for air leakage in accordance with the procedure set out in Appendix B, no such testing of low- or medium-pressure ductwork is required unless so stated in the job specification (see 6.4).**

Part One – Technical Information
to be provided by designer

1 STANDARDS

For each ductwork system, the designer shall provide the information covered by 1.1 and 1.2, and shall also state any departure from the standard specification in respect of 1.3, 1.4 and 1.5.

1.1 Pressure classification *(Table 1)*
1.2 Leakage classification *(Table 2)*
1.3 Materials *(Section 7)*
1.4 Negative pressures *(Table 1)*
1.5 Variable air volume *(Section 9.2)*

2 COMPONENTS

The designer shall (where relevant and practicable) provide information in respect of the items 2.1 to 2.5.

2.1 Access openings *(Section 21)*
Number and location of all access doors, access panels, test holes and instrument openings, other than those regarded as standard practice.

2.2 Control dampers *(Section 22)*
Details and location of all control dampers.

2.3 Fire dampers *(Section 23)*
Specification and location of all fire dampers to meet the requirements of the Authority directly concerned with fire regulations.

2.4 Bendable/flexible ducts *(Sections 24 and 25)*
Details and location of any flexible ducts and connections.

2.5 Flexible joints *(Section 26)*
Details and location of any flexible joints.

3 SPECIAL REQUIREMENTS

The designer shall also (where relevant and practicable) provide information in respect of the items 3.1 to 3.10.

3.1 Air leakage testing
The extent of any leakage testing required for ductwork other than high-pressure *(see 6.4)*; and the method of testing if different from that set out in Appendix B (page 77).

3.2 Protective treatments *(Section 28)*
Details and specification of any fire resistant or other special protective treatment.

3.3 Special finishes *(Section 28)*
Details of any special finishes required, e.g. galvanizing after manufacture, metal spraying, plating, anodizing, special paints.

3.4 Thermal insulation *(Section 31)*
The extent (if any) to which the ductwork is to be insulated and details of the type of insulation to be applied.

3.5 Vapour sealing *(Section 19.6)*
The extent (if any) to which vapour sealing is to be applied to insulated ductwork; and if so, whether to be to Method 1 or Method 2.

3.6 Acoustic treatment *(Section 30)*
The extent (if any) to which any acoustic lining or any other treatment is to be provided for the ductwork; and by whom, with detailed specification.

3.7 Attachment to building structure *(Sections 19 and 29)*
Details of any limitations on the attachment of the ductwork to the building structure (including any special provisions designed to prevent the transmission of vibration; or of any spanning steelwork or special ductwork supports not covered by this specification.

3.8 Variable air volume systems
Identification of any part of the ductwork system requiring modified construction, e.g. to counteract exceptional changes in pressure when the system is in operation which might otherwise give rise to an 'oil-canning' effect.

3.9 Negative pressures
Any exceptional stiffening required to prevent unacceptable panel distortion and excessive air leakage if negative pressures are likely to exceed the limits set out in Table 1 (page 13).

3.10 Other requirements
Details of any requirements for the ductwork not in accordance with the provisions of this specification, including any modified construction required to conform with any regulations concerning external ductwork or to meet the requirements of a local authority or other controlling body.

HEATING AND VENTILATING
HVCA
CONTRACTORS' ASSOCIATION

DW/142

Specification for sheet metal ductwork

Low, medium and high pressure/velocity air systems 1982

ISBN 0 903783 04 5

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Cumbria, CA10 2BX
Telephone: Penrith (0768) 64771 Telex: 64326
Price: £20 (including inland postage)
Overseas: Surface mail £22 Air Mail £27

Previous sheet metal ductwork specifications

–	Ductwork Specification for High-Velocity Air Systems (Circular)	1963
–	Standard Range of Rectangular Ducting	1967
DW/131	Sheet Metal Ductwork Specification for High-Velocity Air Systems (Rectangular)	1968
DW/121	Specification for Sheet Metal Ductwork (Low-Velocity Low-Pressure Air Systems) (Rectangular and Circular) – Metric	1969
DW/122B	Specification for Sheet Metal Ductwork (Low-Veleocity Low-Pressure Air Systems) (Rectangular and Circular) – British	1969
DW/112	Standard Range of Rectangular Ducts and Fittings – Metric and British Units	1970
DW/132	Specification for Sheet Metal Ductwork (High-Velocity High-Pressure Air Systems) (Rectangular, Circular and Flat Oval) – Metric	1970
DW/141	Specification for Sheet Metal Ductwork (Low- and High-Velocity/Pressure Air Systems) (Rectangular, Circular and Flat Oval) – Metric	1977

Note

THIS SPECIFICATION was prepared by a Drafting Panel representing a wide range of interests – ductwork contractors, general mechanical services contractors, consulting engineers, quantity surveyors, research associations, hospital authorities, equipment manufacturers and others. In key areas, extensive testing was carried out by the Building Services Research and Information Association to establish the reliability of the provisions contained herein.

While therefore the greatest care has been taken to ensure the validity and reliability of the provisions in the specification, the Heating and Ventilating Contractors' Association accepts no liability for the operation or performance of any of the materials, devices or methods described herein.

In particular, HVCA does not assume any responsibility for the quality, integrity or performance of any proprietary device referred to herein.

ACKNOWLEDGEMENTS

The HVCA records its appreciation and thanks to the many persons and organisations who have freely given information on various aspects of this work, and in particular to the members of the Drafting Panel, who contributed unstintingly of their knowledge and experience.

DW/142 Drafting Panel

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J. M. Paynton *(Secretary, Duct Work Group)*

Contents

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List of Illustrations

PREFACE

In our rapidly changing environment, engineering specifications need frequent reassessment. The specification DW/141 (published in 1977) was no exception.

This new specification DW/142 in no way minimises the widespread acceptance of its predecessor as the yardstick for the manufacture and installation of ductwork. Constructional principles have changed little, but in order to meet the needs of designers, a medium-pressure class has been introduced. Further, the requirements of energy-conscious users have necessitated the introduction for the first time of performance levels in terms of air leakage for all classes of ductwork.

The establishment of such leakage limits does not imply that all installed ductwork needs to be pressure tested. This new specification if conscientiously followed during construction and erection will produce low-leakage ductwork and will in general obviate the need for costly site testing.

The Duct Work Group of HVCA has for well over twenty years been engaged in the compilation of specifications for the construction and installation of ductwork. The principles underlying this work have ever been that the client should obtain a reliable product, made in accordance with the best technology available at the time, and that the specification should make it possible for good ductwork to be made by the small firm using traditional methods as well as by the large firm using computers and automated machinery. I believe that we have succeeded in these aims, and the evidence to support that claim is to be found in the growing acceptance and status worldwide of the HVCA's ductwork specifications.

I would like to emphasize an important point. Just as DW/142 throws more responsibility on the ductwork contractor, so it does also on the designer to specify his requirements in greater detail than he has in many instances in the past, for both technical and contractual reasons.

It was a conscious policy of the Executive Committee of the Duct Work Group to consult widely in the compilation of DW/142, and the Drafting Panel therefore included not only representatives of ductwork contractors, but also of general mechanical services engineers, the hospital authorities, consulting engineers and of the industry's research association. A large number of other individuals and firms were consulted on specific matters. Our thanks are due to them for their interest in the work and for their valuable contribution to making this new ductwork specification the outstanding work that it is.

My special thanks are due to Mr. W. R. Cox, our technical consultant, and to Mr. J. M. Paynton, the Secretary of the Duct Work Group. Together they have reduced to order a vast amount of raw material. As before, Mr. Paynton has been responsible for the planning, typography and design of the book itself.

R. J. Pitt,
Chairman, Executive Committee,
Duct Work Group, 1981/82

FOREWORD

Since the publication of ductwork specification DW/141 in mid-1977, the need for energy conservation has been universally recognised, and in respect of the HVCA ductwork specification this has been expressed in an emphatic demand from many quarters for ductwork with a known rate of air leakage. This new specification therefore provides leakage limits for all the ductwork covered by it.

Enquiries among designers have shown that the classification of ductwork used in DW/141 no longer accords with practice, as the low-pressure specification was being used for systems in part of which maximum operating pressures exceeded 500 Pa, and operating pressures above 1500 Pa were being avoided because of high energy cost. The classifications in DW/142 have therefore been extended and now cover constructional requirements and leakage limits for low-, medium- and high-pressure ductwork, with the high-pressure classification *in two parts* so that the standard of airtightness can be matched more closely to the operating pressure.

Testing for air leakage remains mandatory for high-pressure ductwork, but is not for low- and medium-pressure ductwork. (The testing procedure in DW/142 now covers all the pressure classes.)

Pressure the main factor

Pressure rather than velocity is the basis of classification used in DW/142, because air leakage is almost entirely a function of pressure, and pressure, not velocity, is the main factor in determining duct strength and panel deflection.

Reappraisal of constructional and erection requirements

The new approach described above has necessitated a reappraisal of constructional and erection requirements in relation to performance under working pressures.

The constructional tables in DW/141 were based on practical experience, supplemented by the results of tests commissioned by HVCA or made available from other sources; and on the information provided by manufacturers of proprietary materials.

With the introduction of leakage limits for all classes of ductwork, more precise information was needed on leakage from ductwork under pressure. In 1979 the Building Services Research and Information Association carried out on behalf of HVCA a series of tests designed to establish norms for the types of longitudinal seams and cross joints included in DW/141, and this work confirmed that the leakage limits proposed by EUROVENT could be accepted for ductwork manufactured and erected to the requirements of DW/142.

The leakage limits for EUROVENT classifications A, B and C, as set out in their Document 2/2 (Air Leakage in Ductwork), have therefore been adopted for the low- and the medium- and for the high-pressure Class C classifications in DW/142. Document 2/2 has no standard for a leakage class equivalent to our Class D, for which DW/142 retains the leakage limits used in DW/141 for high-pressure ductwork.

The new range of pressures required further investigation of the rigidity of cross joints and stiffening. By using the results of tests carried out in 1966 by the then Heating and Ventilating Research Association (now BSRIA) on high-pressure rectangular ducts, the stiffness under operating conditions of all the I-section cross joints could be compared by a relatively simple testing procedure. BSRIA carried out such tests on behalf of HVCA in 1980.

With this more precise information available, the constructional tables have been rearranged to give the limits, in terms of duct size and stiffener spacing, for all the pressure classes.

Design function facilitated

The inclusion of leakage limits in relation to duct surface area will enable the designer to allow for leakage more precisely in his calculations. This in turn will reveal what level of airtightness is needed to maintain the terminal air flow. For the air handling system where the ratio of duct area to air flow falls within the normal range, the pressure classification will establish the degree of airtightness, and the designer will only need to specify the class. But where the duct area is disproportionately large in relation to air flow, the designer may need to call for a higher class in order to keep total air loss through leakage within an acceptable figure.

Leakage limits resulting from the application of the formula used in the EUROVENT Document 2/2 are set out in Table 2 for the three classes of ductwork A, B and C, and also for D, for which Document 2/2 has no equivalent. These pressure/leakage relationships are shown graphically on page 75, and air loss as a *percentage* of air flow on page 76.

Contractual implications of DW/142

It is necessary for all concerned with ductwork installation to appreciate the contractual implications of DW/142.

It will serve no one's interest for the specifier to shelve his responsibilities by stating: 'Ductwork to be to DW/142' and to leave it at that. DW/142 has performance levels for all the pressure bands covered by it. The specifier must therefore clearly state at what pressure level or levels the system is designed to operate, so that the ductwork contractor may select the appropriate constructional details and not incur unnecessary manufacturing costs. Further, as the leakage testing of low- and medium-pressure ductwork is not mandatory, the specifier must positively state his requirements in this respect, as the additional complexity in relation to the installation process, and the significant additional cost, of the testing operation must be provided for by the ductwork contractor.

DW/142 specifies a performance level in respect of air leakage *for the ductwork alone.* It does not and in the circumstances cannot specify a performance requirement *for the whole of the air distribution system,* as the numerous items of equipment forming part of the total air distribution system are not manufactured by the ductwork contractor, who frequently has no voice in choosing such equipment or knowledge of or control over its air containment characteristics.

The ductwork contractor will therefore usually have fulfilled his obligations if he is able to demonstrate that air leakage from the ductwork is within the limits relevant to the pressure class.

General updating

In preparing DW/142, the opportunity has been taken to incorporate modifications and additions arising from the experience gained in the application of DW/141 and of technical developments since the latter was published.

In order to help the designer to provide as soon as possible all the information relevant to the ductwork contract, the section 'Technical Information to be Provided by Designer' has been lifted out of the body of the specification and transferred to a flap attached to the front cover.

The standardisation of names and descriptions of duct fitting will prove of value to all concerned with ductwork design and fabrication, particularly the increasing number of firms using computers in their work.

The provisions covering hangers and supports (Part Six) have been updated and expanded to bring this important aspect of ductwork installation into line with contemporary practice.

The appendices on stainless and pre-coated steel ductwork and aluminium ductwork will prove of value in cases where the conditions are such to warrant the use of ductwork made therefrom.

Advice on transport, handling and storage of ductwork has been included in an appendix.

Finally, mention should be made of the new publication of the Chartered Institution of Building Services – the Design Notes for Ductwork. This for the first time has codified the available information on duct design, and is a worthy complement to the practical constructional and installation provisions in DW/142.

J. H. G. Gardner,
Chairman, DW/142 Drafting Panel

Notes

In this document:

(1) The expressions 'low-pressure,' 'medium-pressure' and 'high-pressure' relate to the pressure/velocity classes set out in Table 1.

(2) 'Mean air velocity' means the design volume flow rate related to the cross-sectional area.

(3) Reference to the air distribution system pressure relate to the static pressure of the relevant part of the ductwork system and not to the fan static pressure.

(4) The symbol for litres is 'L': 1000 litres per second is equivalent to 1 cubic metre per second.

(5) The pascal (Pa) is the internationally agreed unit of pressure. The relationship of the pascal to other units of pressure is: 500 pascals = 500 Newtons per square metre = 5 millibars = approximately 2 inches water gauge.

(6) All dimensions quoted in this specification refer to the nominal sizes, which are subject to the normal relevant commercial and published tolerances.

(7) This specification includes a number of proprietary devices. Where in respect of any such device there is divergence between the requirements of DW/142 and the manufacturer's recommendations for use, the former shall take precedence.

Duct pressure classification

As the static pressure in a duct system progressively changes from the fan, economic advantage can be obtained by changing the duct pressure classification to match more closely the duct distribution static pressure.

For example, some large systems could well be classified for leakage limits as follows:

Plant rooms and risers	Class C
Main floor distribution	Class B
Low-pressure outlets	Class A

Part Two – Standards

4 APPLICATION

4.1 This specification sets out minimum requirements for the manufacture and installation of ductwork for air distribution systems, made from any of the materials listed in Section 7 and being within the limits of size and/or metal thicknesses specified in the relevant tables and operating at normal temperatures within the pressure and velocity limits specified in Table 1. The specification also prescribes (Table 2) the limits of air leakage for the various pressure classes.

4.2 Unless stated otherwise, the methods and devices described herein apply to all the pressure classes set out in Table 1.

4.3 This specification is not intended to apply to ductwork handling air which is polluted or is otherwise exceptional in respect of temperature or humidity (including saturated air); nor is it suitable for ductwork exposed to a hostile environment, e.g. contaminated air, off-shore oil rigs, etc. The design, construction, installation, supports and finishes in such cases should be given special consideration in relation to the circumstances of each case. This specification is also not intended to apply to domestic warm air installations.

5 DUCTWORK CLASSIFICATION

5.1 This specification is based on the pressure classes set out in Table 1.

Table 1 Ductwork Classification

Duct pressure class	Static pressure limit		Mean air velocity (maximum)	Air leakage
	Positive	Negative		
1	*2*	*3*	*4*	*5*
Low	Pa 500	Pa 500	m/sec 10	Class A
Medium	1000	750	20	Class B
High	2000	750	40	Class C
	2500	750	40	Class D

6 AIR LEAKAGE STANDARDS

6.1 Limits for each pressure class
Permitted air leakage is related to four standards of airtightness, as set out in Table 2.

6.2 Compatibility with EUROVENT
The leakage factors used in Table 2 for Classes A, B and C are the same as those used for the classes similarly designated in the EUROVENT Document 2/2 (Air Leakage in Ductwork).

6.3 Leakage at various pressures; and other relationships
Applying the limits specified in Table 2, Appendix A (Table 31) sets out the permitted leakage at each of a series of pressures up to the maximum for each class. Included in that appendix is a graphical presentation of the pressure/leakage relationship; and also charts from which may be determined leakage as a percentage of airflow for classes A, B or C.

Appendix A also gives details of the basis for the leakage limits specified in Table 2.

Table 2 Air Leakage Limits

Air leakage	Leakage limit
1	*2*
Low-pressure– Class A	litres per second per square metre of duct surface area $0.027 \times p^{0.65}$
Medium-pressure– Class B	$0.009 \times p^{0.65}$
High-pressure– Class C	$0.003 \times p^{0.65}$
High-pressure– Class D	$0.001 \times p^{0.65}$

where p is the differential pressure in pascals

6.4 Testing for air leakage
All ductwork operating at pressures classified in this specification as 'high pressure' shall be tested to establish conformity with the relevant leakage limits set out in Table 2.

Testing for leakage of ductwork operating within the low and medium ranges of pressure in this specification will not form part of the ductwork contract unless this requirement is set out in the job specification – see also Note (2) on page 1.

7 MATERIALS

7.1 Applicability

This specification applies to ductwork made from materials as defined below, or equal. ('Sheet' is to be understood to include coil.)

7.2 Zinc-coated steel

7.2.1 Ductwork will normally be made from hot-dip galvanized sheet to BS 2989, Grade Z2, coating type, or equal. If this is not available, alternative types are:

7.2.2 Hot-dip galvanized sheet to BS 2989, Grade Z2 or Grade Z3, with iron-zinc alloy coating type IZ.100 or IZ.180, or equal.

7.2.3 Cold-reduced sheet to BS 1449, Grade CR4, having a zinc coating applied by electroplating (coating thickness 2.5 microns), or equal.

7.3 Black steel

Where black sheet is specified, it shall be cold-reduced steel sheet to BS 1449: Part 1, Grade CR4 GP, or equal.

7.4 Stainless steel

Where stainless steel sheet is specified, it will be the responsibility of the designer to indicate the type most suitable for the conditions in which the ductwork will be exposed. In doing so, it is recommended that the factors set out in Appendix G should be taken into account. In this connection, regard should be had to BS 1449: Part 2, which includes stainless steel sheet and strip.

7.5 Pre-coated steel

If the designer for aesthetic or other reasons specifies the use of pre-coated steel for the ductwork, he should consider the availability of the material and the restrictions on fabrication methods – see Appendix H.

7.6 Aluminium

Where aluminium sheet is specified, it will be the responsibility of the designer to indicate the type most suitable for the conditions to which the ductwork will be exposed. In so doing, regard should be had to BS 1470 for aluminium sheet and BS 1474 for aluminium section. (See Section 20 herein for constructional requirements for ductwork made from aluminium sheet, and Appendix J for some general notes on the material.)

Part Three – Rectangular Ducts

8 STANDARD RANGE OF RECTANGULAR DUCT SIZES

8.1 Standard range

Table 3 represents the range of standard sizes of rectangular ducts which at the time of preparing DW/142 were being processed by the International Standards Organisation as an ISO Standard. (*Note.* – The sizes in Table 3 are the same as those in Table 1 of DW/141.)

8.2 Unusual aspect ratios

Duct sizes with an aspect ratio greater than 4:1 are not recommended. Although they offer no problems of construction, they increase frictional resistance and the possibility of noise.

9 CONSTRUCTION

9.1 General

The main constructional requirements for rectangular ductwork have been established following independent tests, the limits of use being related to the characteristics of rolled steel angle. (See 9.5 for longitudinal seams, 9.6 for cross joints and 9.7 for stiffeners.)

9.2 Variable air volume systems

The requirements for sheet thickness and stiffening set out in the relevant tables shall, unless otherwise specified by the designer, apply to ductwork for VAV systems (see also 3.8 in Part One – Technical Information to be Provided by Designer – inside flap).

9.3 Sealants and gaskets

Special attention is drawn to the requirements for the use of sealants and gaskets, as the case may be, in relation to the various longitudinal seams and cross joints included in this specification. (Section 27 sets out the desirable characteristics of sealants, gaskets and tapes.)

Table 3 Standard sizes of rectangular ducts

Long side (mm)	Short side (mm)										
	100	150	200	250	300	400	500	600	800	1000	1200
150	0.50	0.60									
200	0.60	0.70	0.80								
250	0.70	0.80	0.90	1.00							
300	0.80	0.90	1.00	1.10	1.20						
400	1.00	1.10	1.20	1.30	1.40	1.60					
500		1.30	1.40	1.50	1.60	1.80	2.00				
600		1.50	1.60	1.70	1.80	2.00	2.20	2.40			
800			2.00	2.10	2.20	2.40	2.60	2.80	3.20		
1000				2.50	2.60	2.80	3.00	3.20	3.60	4.00	
1200					3.00	3.20	3.40	3.60	4.00	4.40	4.80
1400						3.60	3.80	4.00	4.40	4.80	5.20
1600						4.00	4.20	4.40	4.80	5.20	5.60
1800							4.60	4.80	5.20	5.60	6.00
2000							5.00	5.20	5.60	6.00	6 40

The figures inside the boxes represent the surface area of the ducts, in square metres per metre length

9.4 Sheet thicknesses

Minimum sheet thicknesses related to duct longer side and to pressure classification are given in Table 4. (This information is also included in Tables 5 to 8.)

Table 4 Minimum sheet thicknesses – Rectangular ducts

Maximum duct size (longer side)	Sheet thickness	
	Low- and medium-pressure ducts	High-pressure ducts
1	*2*	*3*
mm	mm	mm
400	0.6	0.8
600	0.8	0.8
800	0.8	0.8
1000	0.8	0.8
1250	1.0	1.0
1600	1.0	1.0
2000	1.0	1.2
2500	1.0	1.2
3000	1.2	–

9.5 Longitudinal seams

9.5.1 Types available

Longitudinal seams are illustrated in Figs. 1 to 7. The limits of use, if any, are given with the individual illustrations.

9.5.2 Sealant in longitudinal seams

Sealant shall be used with all longitudinal seams, irrespective of the pressure class. The sealant may be included in the seam during manufacture or be applied as edge sealant.

9.5.3 Welded seams

As the exception to the requirements of 9.5.2, a welded seam is acceptable without sealant, provided that the welding is continuous.

9.6 Cross joints

9.6.1 Cross joint ratings

For cross joints, a system of rating has been used to define the limits of use. The rating for each cross joint is given with its drawing, and the limits applying to that rating, in terms of duct size longer side and maximum spacing, are given in Tables 5 to 8. Other limits on use are given with the individual drawings.

The system of ratings is as follows:

Socket and spigot joints – A1 to A3 (Figs. 9 to 12)
Cleated joints – C1 to C4 (Figs. 20 to 24)
Flanged joints – J1 to J6 (Figs. 33 to 43)

9.6.2 Corners and junctions

Socket and spigot joint corners and junctions are illustrated in Figs. 13 to 19.

Cleated joint corners and junctions are illustrated in Figs. 25 to 32.

Details of the corner treatments of flanged joints are included with their illustrations – Figs. 33 to 43.

9.6.3 Sealant in cross joints

Sealant shall be used between sheet and section in all cross joint assemblies.

With **cleated joints**, the sealant shall be applied during or after the assembly of the joint.

With **socket and spigot joints made on site**, sealant shall be applied during or after assembly of the joint. It is permissible to use chemical-reaction tape or heat-shrink strip (but *not* continuous band) as alternative methods of sealing, provided that close contact is maintained over the whole perimeter of the joint until the joint is completed.

With all **flanged joints**, the sealant between sheet and section should preferably be incorporated during construction at works, but edge sealant is acceptable. The joint between sections of ductwork is then made, using an approved type of sealant or gasket (see Section 27).

9.7 Stiffeners

9.7.1 General

Stiffeners shall be applied so that the true rectangular cross-section of the duct is maintained.

9.7.2 External stiffeners

The sections (including proprietary flanges) suitable for use as **single stiffeners** have been given a rating from S1 to S6 in terms of duct size longer side and maximum spacing. The ratings are specified with the illustrations of the stiffeners, Figs. 44 to 49, and the limits of use are given in Tables 5 to 8. The girth stiffeners for socket and spigot joints covered in Fig. 12 are also applicable to girth stiffeners in general.

9.7.3 Internal stiffeners

Tie bars connecting the flanges of cross joints or intermediate stiffeners are the only form of internal stiffening for rectangular ductwork covered in this specification. (For the use of tie bars in flat oval ductwork, see 16.4.) Other forms of internal stiffening or bracing are not recommended.

The use of tie bars in rectangular ducts shall be authorised by the designer; and if circumstances require the use of internal stiffening in *any* other form, the method to be used shall be approved by the designer.

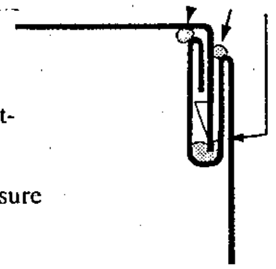
Alternative methods of attachment of tie bars are shown in Fig. 50.

Examples of the application of the joint and stiffener rating system are given on pages 22 and 23.

Longitudinal seams

For permitted fastenings (types and spacing), see Table 10 (page 21)

Fig. 4 Button punch snap lock seam



Note. – This seam is acceptable for use on low- and medium-pressure ducts only

Fig. 1 Grooved seam

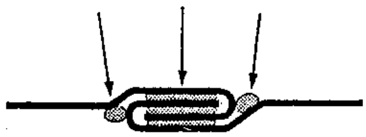


Fig. 5 Standing seam (internal or external) Minimum height 15 mm

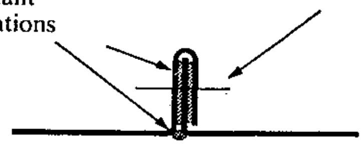


Fig. 2 Grooved corner seam

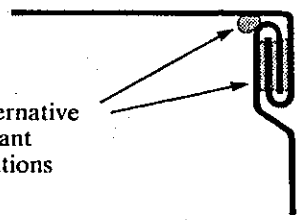


Fig. 6 Capped standing seam (internal or external) Minimum height 15 mm

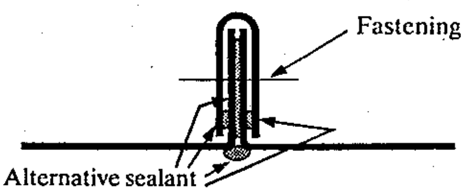


Fig. 3 Pittsburgh lock seam

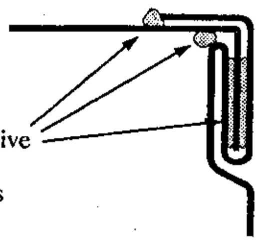
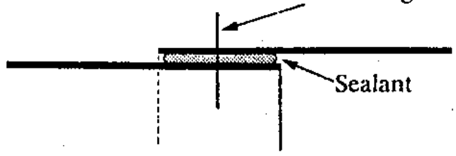


Fig. 7 Lap seam



Note. – This seam is acceptable for use on low- and medium-pressure ducts only

Constructional Requirements – Rectangular Ducts
Table 5 LOW PRESSURE (up to 500 Pa)

Dimensions in mm

Maximum duct size (longer side) or → length of stiffeners			400	600	800	1000	1250	1600	2000	2500	3000
Minimum sheet thickness →			0.6	0.8			1.0				1.2
Type	Rating	Sheet	Maximum spacing between joints and stiffeners								
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Socket & Spigot Joints	A1	PS	3000								
		SS	3000								
	A2	PS	3000	2000	1600	1250					
		SS	3000	3000	1600	1250					
	A3	PS	3000	2000	1600	1250	1000	800			
		SS	3000	3000	2000	1600	1250	800			
Cleated Joints	C1	PS	3000	1600							
		SS	3000	3000							
	C2	PS	3000	2000	1600	1250					
		SS	3000	3000	2000	1250					
	C3	PS	3000	2000	1600	1250	1000				
		SS	3000	3000	1600	1250	1000				
	C4	PS	3000	3000	1600	1250	1000	800			
		SS	3000	3000	2000	1600	1250	800			
Flanged Joints & Stiffeners	J1/S1	PS	3000	1600	1250	625					
		SS	3000	3000	1250	625					
	J2/S2	PS	3000	2000	1600	1250	625				
		SS	3000	3000	1600	1250	625				
	J3/S3	PS	3000	2000	1600	1250	1000	800			
		SS	3000	3000	2000	1600	1250	800			
	J4/S4	PS	3000	2000	1600	1250	1000	800	800		
		SS	3000	3000	2000	1600	1250	1000	800		
	J5/S5	PS	3000	2000	1600	1250	1000	800	800	800	625
		SS	3000	3000	2000	1600	1250	1000	800	800	800
	J6/S6	PS	3000	2000	1600	1250	1000	800	800	800	800
		SS	3000	3000	2000	1600	1250	1000	800	800	800

Notes

In the constructional tables 5 to 8:

(1) The joints and stiffeners have been rated in terms of duct longer side and maximum spacing – see 9.6.1 for joints and 9.7.1 for stiffeners.

(2) In Col. 3:
'PS' = plain sheet;
'SS' = stiffened sheet, by means of:
(a) beading at 400 mm maximum centres: *or* (b) cross-breaking within the frame formed by joints and/or stiffeners: *or* (c) pleating.

Constructional Requirements – Rectangular Ducts
Table 6 MEDIUM PRESSURE (up to 1000 Pa)

Dimensions in mm

Maximum duct size (longer side) or → length of stiffeners			400	600	800	1000	1250	1600	2000	2500	3000
Minimum sheet thickness→			0.6	0.8			1.0				1.2
Type	Rating	Sheet	Maximum spacing between joints and stiffeners								
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Socket & Spigot Joints	A1	PS	3000								
		SS	3000								
	A2	PS	3000								
		SS	3000								
	A3	PS	3000	1600	1250	1000	800				
		SS	3000	3000	1600	1250	800				
Cleated Joints	C1	PS	3000								
		SS	3000								
	C2	PS	3000	1600							
		SS	3000	3000							
	C3	PS	3000	1600							
		SS	3000	3000							
	C4	PS	3000	1600							
		SS	3000	3000							
Flanged Joints & Stiffeners	J1/S1	PS	3000	1250	625						
		SS	3000	1250	625						
	J2/S2	PS	3000	1250	1250	625					
		SS	3000	1600	1250	625					
	J3/S3	PS	3000	1600	1250	1000	800				
		SS	3000	3000	1600	1250	800				
	J4/S4	PS	3000	1600	1250	1000	800	800			
		SS	3000	3000	1600	1250	1000	800			
	J5/S5	PS	3000	1600	1250	1000	800	800	800	625	
		SS	3000	3000	1600	1250	1000	800	800	800	
	J6/S6	PS	3000	1600	1250	1000	800	800	800	800	625
		SS	3000	3000	1600	1250	1000	800	800	800	625

(3) Limits of length of single stiffeners apply to opposed side (transverse) stiffeners and to longitudinal stiffeners: also to girth stiffeners, irrespective of corner treatment.
(4) With longitudinal stiffeners, maximum spacings apply both between stiffeners and from stiffeners to duct edges.
(5) The choice of lagging may be limited with stiffened panels.
(6) For ductwork galvanized after manufacture, see 9.8 and Table 9.

Constructional Requirements – Rectangular Ducts
Table 7 HIGH PRESSURE (up to 2000 Pa)

Dimensions in mm

Maximum duct size (longer side) or → length of stiffeners			400	600	800	1000	1250	1600	2000	2500
Minimum sheet thickness →			0.8				1.0		1.2	
Type	Rating	Sheet	Maximum spacing between joints and stiffeners							
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Socket & Spigot Joints	A1	PS/SS	3000							
	A2	PS/SS	3000							
	A3	PS/SS	3000							
Flanged Joints & Stiffeners	J1/S1	PS/SS	3000	625						
	J2/S2	PS/SS	3000	1250	800					
	J3/S3	PS/SS	3000	1250	1250	800				
	J4/S4	PS/SS	3000	1250	1250	1250	800			
	J5/S5	PS/SS	3000	1250	1250	1250	800	800	625	
	J6/S6	PS/SS	3000	1250	1250	1250	800	800	800	625

Constructional Requirements – Rectangular Ducts
Table 8 HIGH PRESSURE (up to 2500 Pa)

Dimensions in mm

Maximum duct size (longer side) or → length of stiffeners			400	600	800	1000	1250	1600	2000	2500
Minimum sheet thickness →			0.8				1.0		1.2	
Type	Rating	Sheet	Maximum spacing between joints and stiffeners							
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Socket & Spigot Joints	A1	PS/SS	3000							
	A2	PS/SS	3000							
	A3	PS/SS	3000							
Flanged Joints & Stiffeners	J1/S1	PS/SS	3000	625						
	J2/S2	PS/SS	3000	1250	625					
	J3/S3	PS/SS	3000	1250	1000	625				
	J4/S4	PS/SS	3000	1250	1000	800	625			
	J5/S5	PS/SS	3000	1250	1000	800	625	625		
	J6/S6	PS/SS	3000	1250	1000	800	625	625	625	500

Notes at foot of pages 18 and 19 also apply to Tables 7 and 8

9.8 Ductwork galvanized after manufacture

Table 9 (which is applicable to the low- and medium-pressure classes only) sets out the recommended sheet thicknesses and stiffening for ductwork galvanized after manufacture. (See also Appendix F.)

Table 9 Ductwork galvanized after manufacture (low- and med. pressure only)

Maximum duct size (longer side)	Recommended sheet thickness	Fig. 33 joint rating	Fig. 44 stiffener rating	Maximum spacing for joints/ stiffeners
1	*2*	*3*	*4*	*5*
mm	mm	mm	mm	mm
400	1.2	J3	S2	3000
1000	1.6	J4	S3	1250
1600	1.6	J5	S4	800
2000	1.6	J6	S5	800

9.9 Fastenings

9.9.1 Permitted types and maximum centres

Tables 10 sets out the permitted fastenings and the maximum spacings for low-, medium- and high-pressure rectangular ducts. All duct penetrations shall be sealed.

9.9.2 Rivets

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

9.9.3 Bolts and nuts

Bolts and nuts shall be of mild steel, protected by electro-galvanizing, Sherardizing, cadmium-plating, or other equal and approved finish.

9.9.4 Self-tapping screws

Self-tapping screws, while not recommended, are acceptable in circumstances in which the use of other types of fastening is not practicable.

9.9.5 Welding of sheet

The suitability of welding for sheet-to-sheet fastening will be governed by the sheet thickness, the size and shape of the duct or fitting and the need to ensure airtightness. Welded joints shall provide a smooth internal surface and shall be free from porosity. Distortion shall be kept to a minimum.

Areas where the galvanizing has been damaged or destroyed by welding or brazing shall be suitably prepared and painted internally and externally with zinc-rich or aluminium paint.

10 PLANT CONNECTIONS

10.1 Definition

The term 'plant connection' refers to the sheet metal enclosure joining the components of an air handling assembly and connections between the assembly and the ductwork system.

10.2 Constructional requirements

The maximum operating pressure of the plant shall determine which constructional requirements and leakage limits are applicable to plant connections.

Where access to plant requires entry into the duct, a floor plate connected to the stiffeners should be included so as to prevent local overloading of the sheet metal. If local conditions require heavier construction, the designer should specify appropriately.

Table 10 Fastenings – Rectangular Ducts

Type of fastening	Sheet to sheet			Sheet to section (minimum two per side) Maximum distance from corners 50 mm		
	Longitudinal seams		Cross joints	Cross joints		Angle stiffeners for socket and spigot joints and all intermediate stiffeners
	Lap	Standing and capped standing	Socket and spigot	Rolled steel flanges	All slide-on flanges and flange cleats	
1	*2*	*3*	*4*	*5*	*6*	*7*
	mm	mm	mm	mm	mm	mm
Mechanically closed rivets	60	300	60	150	300	150
Bolts and nuts	—	—	—	150	300	—
Lock bolts	—	300	—	150	300	300
Spot welds	30	150	—	75	300	150
Dimpling	—	150	—	—	150	—

Text continued on page 35 with Section 11 – Fittings

EXAMPLES of the application of the joint rating system (Tables 5 to 8)

Fig. 9 – Plain socket and spigot joint
This joint is rated in Fig. 9 as A1 for all pressure classes, with duct size limited to 400 mm longer side. The tables show that such joints by themselves give adequate stiffening, whether the sheet itself is plain (P) or stiffened (S), provided that they are spaced at not more than 3000 mm.

Fig. 24 – Angle-reinforced double-standing hemmed 'S' cleat
This joint is applicable to the low-pressure class only, and with a 25 x 3 mm angle is rated C3.
Table 5 limits the use of a C3 joint to ducts with longer side not exceeding 1250 mm, and such joints give adequate stiffening at the maximum spacings specified (Cols. 4 to 8 of Table 5), the spacings varying according to whether the sheet itself is plain (P) or stiffened (S).

Figs. 41 and 42 – Slide-on Flanges
These joints are applicable to all the pressure classes, and with a height of 30 mm are rated as J3.
For medium-pressure ducts, Table 6 limits the use of a J3 joint to ducts not exceeding 1250 mm longer side, with joints at 800 mm maximum spacing, whether the sheet itself is plain (P) or stiffened (S).
Where joints are more widely spaced, intermediate stiffeners with an S3 rating (see Figs. 44 to 49) will be necessary to meet the maximum spacing requirements.

Application to individual ductwork contractor's working methods
The individual ductwork contractor will normally apply the rating system to his own requirements by making up tables covering the joints used by him. The following are some examples.

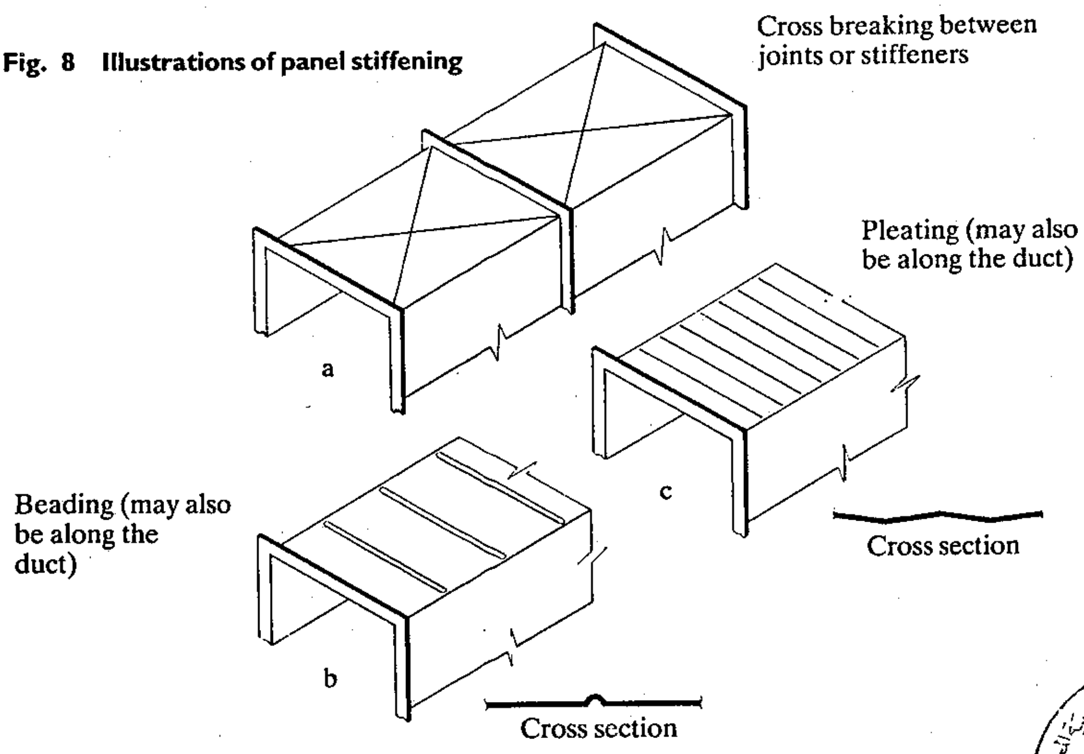
Example 1 SOCKET AND SPIGOT JOINTS FOR LOW-PRESSURE DUCTS

Duct sheet thickness	Duct size longer side or length of stiffener	Fig. No.	Maximum spacing between joints and stiffeners	
			Plain sheet	Stiffened sheet
1	2	3	4	5
mm	mm		mm	mm
0.6	400	9 and 10	3000	3000
0.8	600	11 and 12 25 mm angle	2000	3000
0.8	800	11 and 12 25 mm angle 30 mm angle	 1600 1600	 1600 2000
0.8	1000	11 and 12 25 mm angle 30 mm angle	 1250 1250	 1250 1600
1.0	1250	11 and 12 30 mm angle	1000	1250
1.0	1600	11 and 12 30 mm angle	800	800

Example 2 FLANGE JOINT as Fig. 41 or 42 for LOW-PRESSURE DUCTS

Duct sheet thickness	Duct size longer side or length of stiffener	Flanged joint (flange H size)	RS flange (Fig. 44) used as stiffener (H)	Profile (Figs. 45 to 48) used as stiffener (H)	Maximum spacing between joints and stiffeners	
					Plain sheet	Stiffened sheet
1	*2*	*3*	*4*	*5*	*6*	*7*
mm	mm	mm	mm	mm	mm	mm
0.6	400	20	–	–	3000	3000
0.8	600	20	25	30	2000	3000
0.8	800	20 30	25 30	30 40	1600 1600	1600 2000
0.8	1000	20 30	25 30	30 40	1250 1250	1250 1600
1.0	1250	20 30	25 30	30 40	625 1000	625 1250
1.0	1600	30 40	30 40	40 –	800 800	800 1000
1.0	2000	40	40	–	800	800
1.0	2500	40+ tie bar	50	–	800	800
1.2	3000	40+ tie bar	50	–	625	800

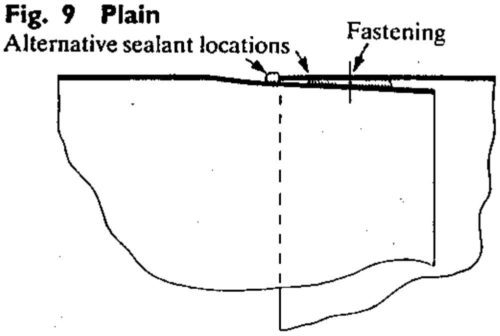
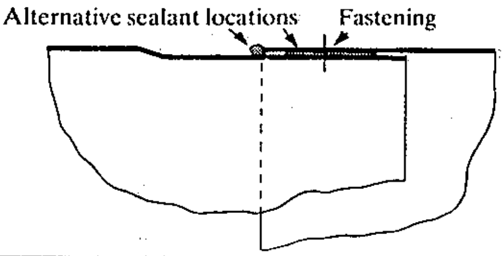
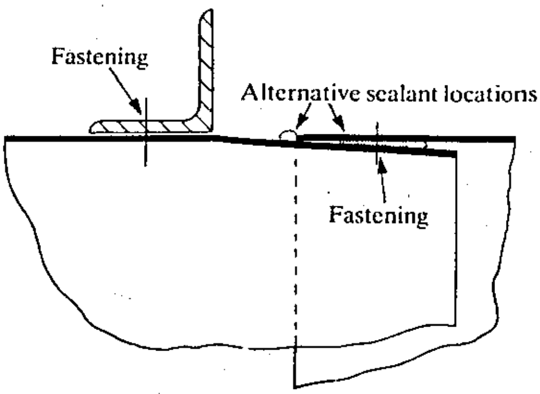
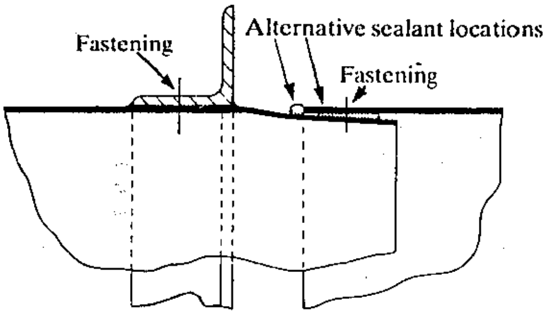
Fig. 8 Illustrations of panel stiffening



Socket and spigot cross joints

Note – Particular care must be taken in the sealing of these joints

For permitted fastenings (types and spacing), see Table 10 (page 19)

Type	Angle size	Rating	Pressure classes	Notes
Fig. 9 Plain 	–	A1	Low Medium High	
Fig. 10 Adjustable 	–	A1	Low Medium High	
Fig. 11 Angle reinforced (opposed sides) 	25 x 3	A2	Low	Applicable only where duct *shorter* side is less than 400 mm
	30 x 4	A3	Low Medium	
Fig. 12 Angle reinforced – full girth 	25 x 3	A2	Low	Stiffeners shown in Figs. 45 to 49 are permissible if provided with rigid corners
	30 x 4	A3	Low Medium	

Socket and spigot joints – corners and junctions

Fig. 13 Grooved seam

Corners notched and closed by dressing. Alternatively, corners may be indented.

Return cut away at each half seam for length of spigot to leave overlap.

Seam compressed at socket to provide a flat side internally.

An adjustable socket and spigot joint as Fig. 10 can be formed by extending the length and welding all four corners of the spigot.

With high-pressure ductwork, spigot corners shall be welded.

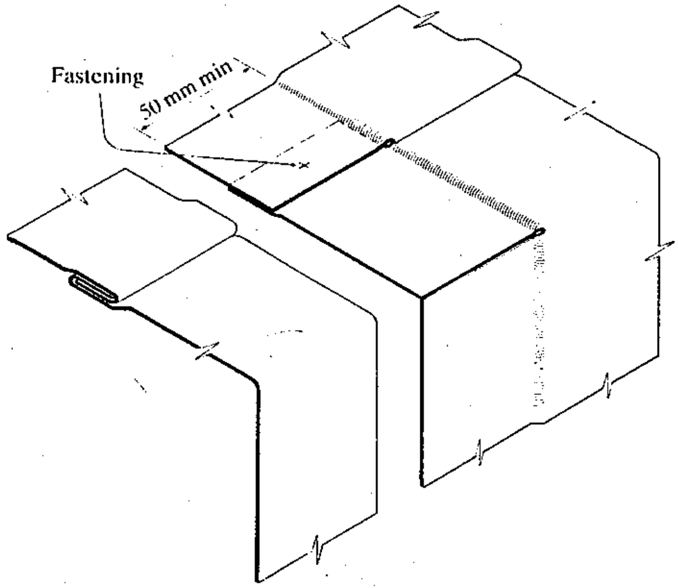


Fig. 14 Grooved corner seam

Corners notched and closed by dressing. Alternatively, the corners may be indented.

Inside of lock form cut back for length of spigot.

Joggle to accommodate lock form at socket end. Alternatively, the lock form may be compressed to provide a flat side to socket internally.

An adjustable socket and spigot joint as Fig. 10 can be formed by extending the length and welding all four corners of the spigot.

With high-pressure ductwork, spigot corners shall be welded.

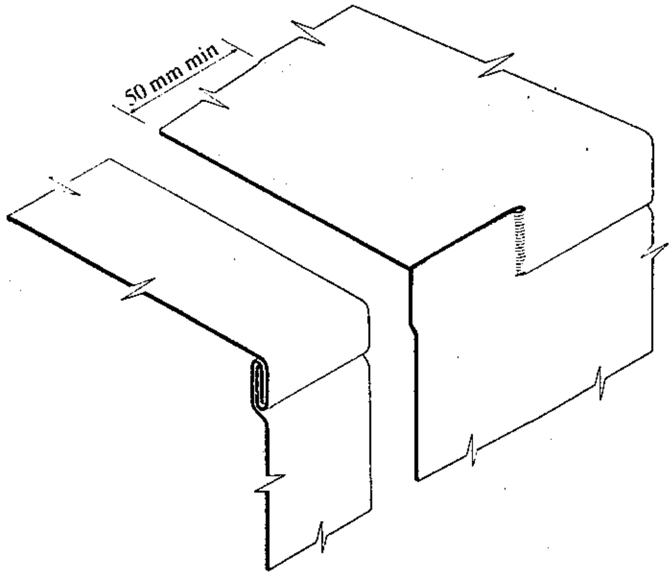


Fig. 15 Pittsburgh lock

Corners notched and closed by dressing. Alternatively, the corners may be indented.

Outside of lock form cut back for length of spigot.

Joggle to accommodate lock form at socket end. Alternatively, the lock form may be compressed to provide a flat side to socket internally.

An adjustable socket and spigot joint as Fig. 10 can be formed by extending the length and welding all four corners of the spigot.

With high-pressure ductwork, spigot corners shall be welded.

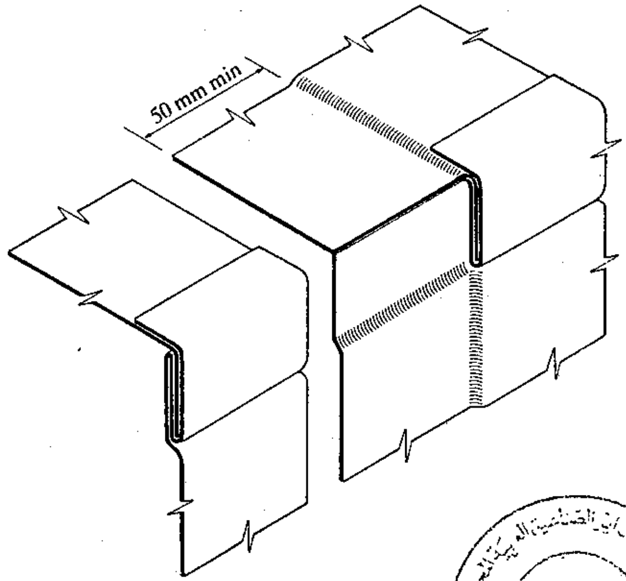


Fig. 16 Button punch snap lock seam

Corners notched and closed by dressing. Alternatively, the corners may be indented.

Inside of lock form cut back for length of spigot.

Joggle to accommodate lock form at socket end. Alternatively, the lock form may be compressed to provide a flat side to socket internally.

An adjustable socket and spigot joint as Fig. 10 can be formed by extending the length and welding all four corners of the spigot.

With high-pressure ductwork, spigot corners shall be welded and lap seam section sealed.

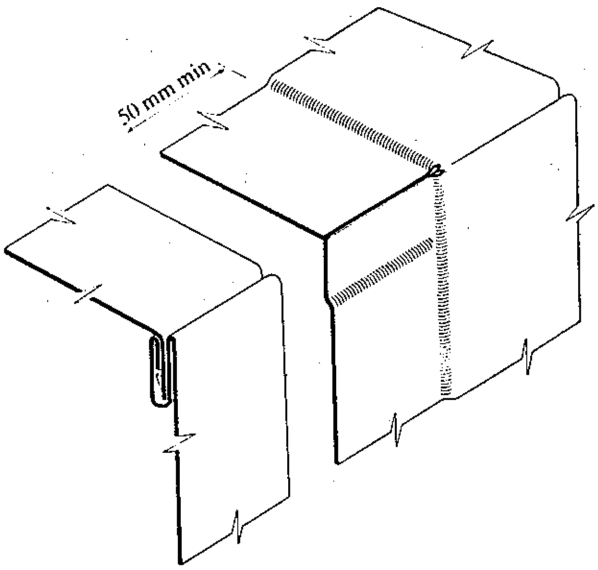


Fig. 17 Standing seam (external)

Corners notched and closed by dressing. Alternatively, the corners may be indented.

Standing double edge cut back and standing single edge flattened for length of spigot to provide overlap.

Seam must be positioned so that it cannot collect or retain water.

An adjustable socket and spigot joint as Fig. 10 can be formed by extending the length and welding all four corners of the spigot if not indented.

With high-pressure ductwork, spigot corners shall be welded.

(Notes apply also to Fig. 18 and Fig. 19)

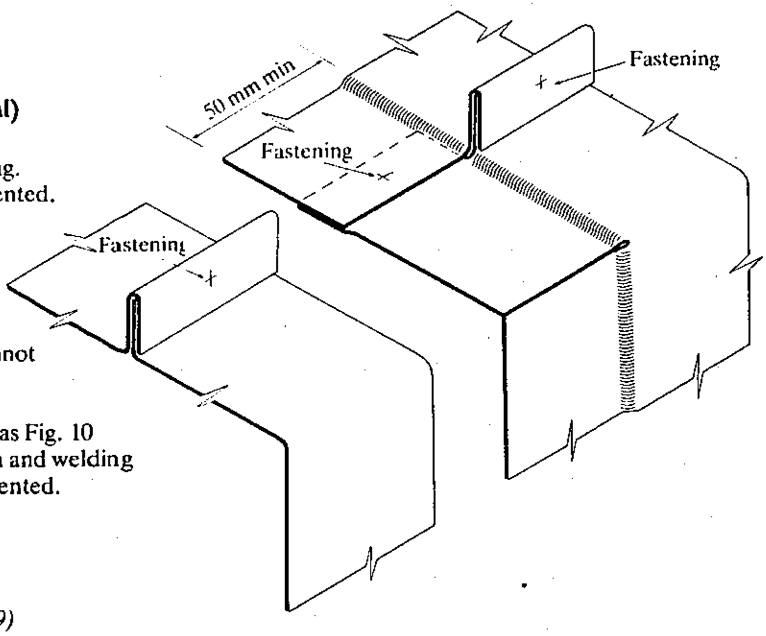


Fig. 18 Standing seam (internal)
(see notes to Fig. 17)

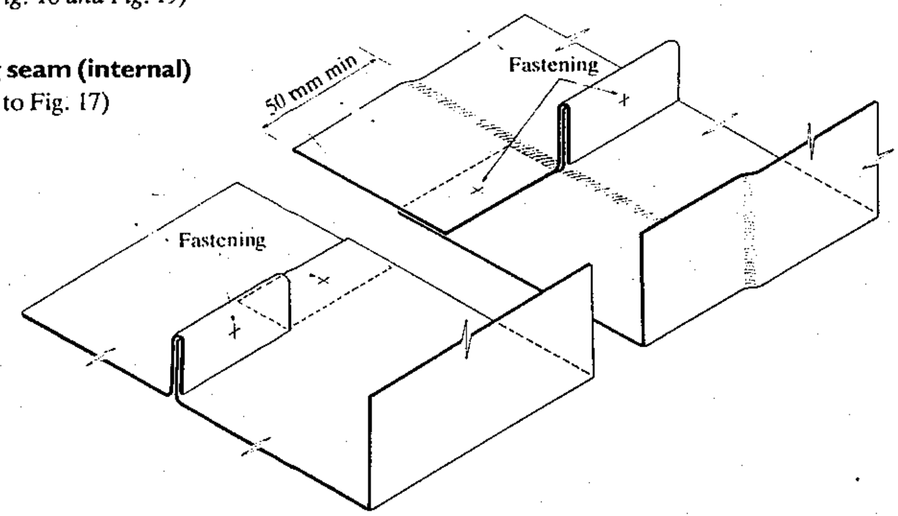
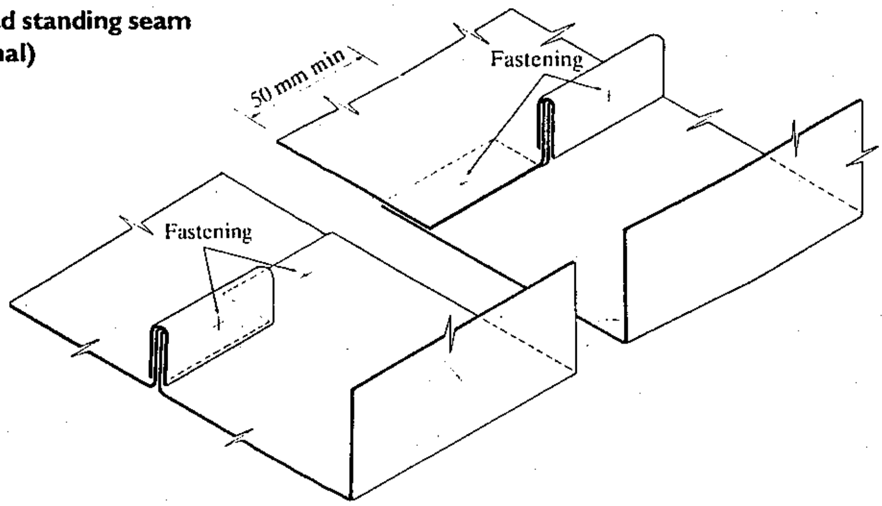
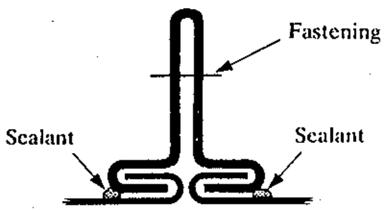
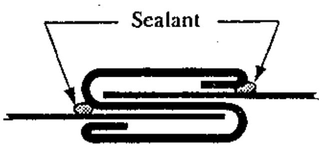
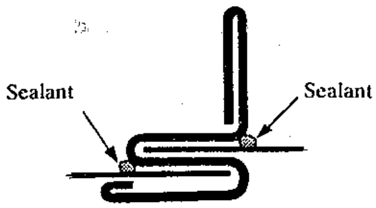
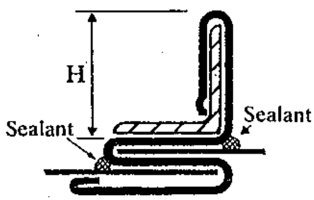


Fig. 19 Capped standing seam (internal)

(Notes to Fig. 17 also apply)



Cleated cross joints

Type	Thick-ness	Rating	Pressure classes	Notes
Fig. 20 'C' cleat 	mm 0.8	C1	Low Medium	Used on all four sides: *or* on opposed sides in combination with 'S' cleat. For intersection with grooved seam see Fig. 25. For intersection with Pittsburgh lock, grooved corner or button punch snap lock seam, see Fig. 27. For folded corner detail, see Figs. 28 and 29.
Fig. 21 Standing 'C' cleat 	0.8	C2	Low Medium	Used on all four sides: *or* on opposed sides in combination with 'S' cleat. Fastened at corners and intermediately at 200 mm centres maximum spacing. For corner detail, see Figs. 30, 31, and 32.
Fig. 22 Hemmed 'S' cleat 	0.6	C1	Low	Used on opposed sides in combination with 'C' cleat. May be used on all four sides if fixed to duct by mechanical fasteners at 300 mm maximum centres. For corner detail, see Figs. 27 and 29. For intersection with grooved seam, see Fig. 26.
Fig. 23 Double standing hemmed 'S' cleat 	0.8	C2	Low	Used with 'C' cleat or standing 'C' cleat on opposed sides. May be used on all four sides if fixed to duct by mechanical fasteners at 300 mm maximum centres. For corner details of 'S' cleat, see Figs. 27, 29 and 31. For intersection with grooved seam, see Fig. 26.
Fig. 24 Angle-reinforced double standing hemmed 'S' cleat 	0.8 with: 25 x 3 angle 40 x 4 angle	C3 C4	Low Low	Used with 'C' cleat or standing 'C' cleat on opposed sides. May be used on all four sides if fixed to duct by mechanical fasteners at 300 mm maximum centres. For corner details of 'S' cleat, see Figs. 27, 29 and 31. For intersection with grooved seam, see Fig. 26.

Cleated cross joints – corners and junctions

Fig. 25 'C' cleat with grooved seam

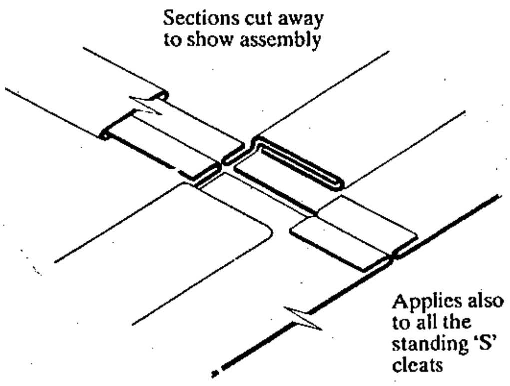


Fig. 26 'S' cleat with grooved seam

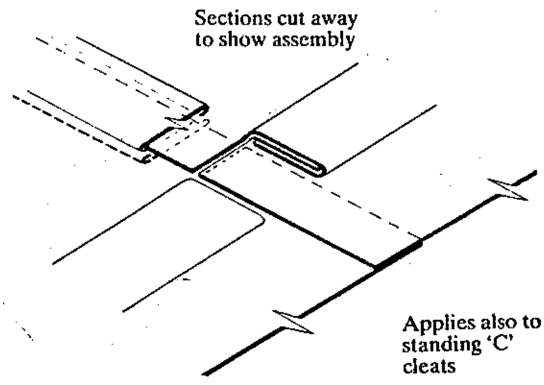


Fig. 27 'S' and 'C' cleat with Pittsburgh lock, grooved corner or button punch snap lock seam

Notes:
1. With 'C' cleats on all four sides, three corners are as (b); the fourth overlapped as illustrated for 'S' cleat (c).
2. (a) and (c) apply also to all the standing 'S' cleats

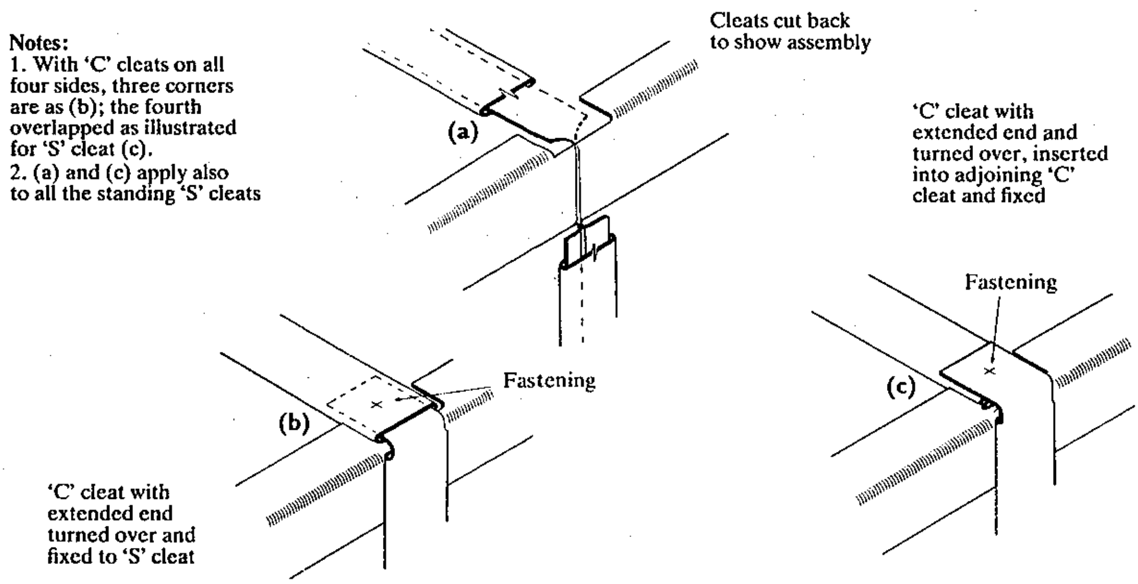


Fig. 28 'C' cleat with folded corner

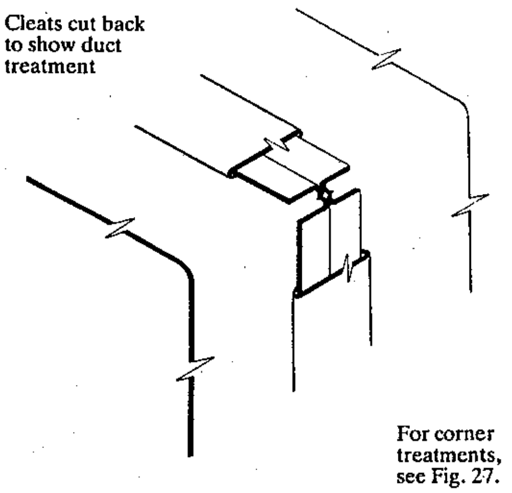
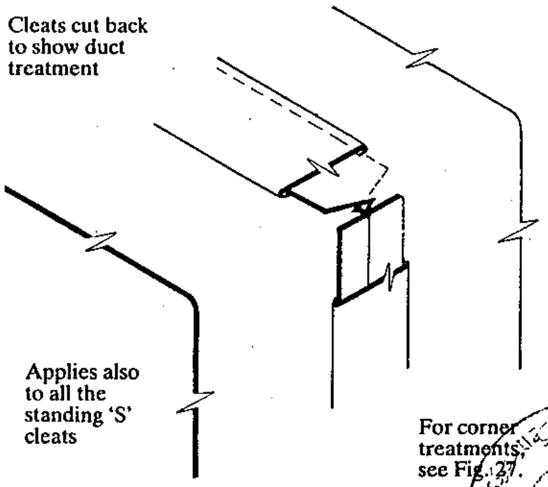


Fig. 29 'S' cleat and 'C' cleat with folded corner



Cleated cross joints – corners and junctions *(continued)*

Fig. 30 Standing 'C' cleat

(treatment for three corners; for fourth corner, see Fig. 31)
Applies also to a combination of standing and plain 'C' cleats

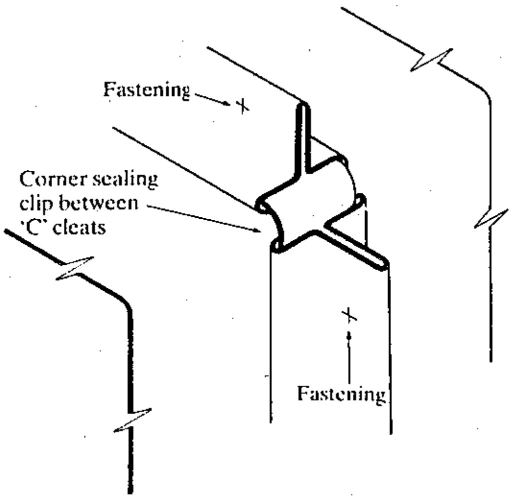
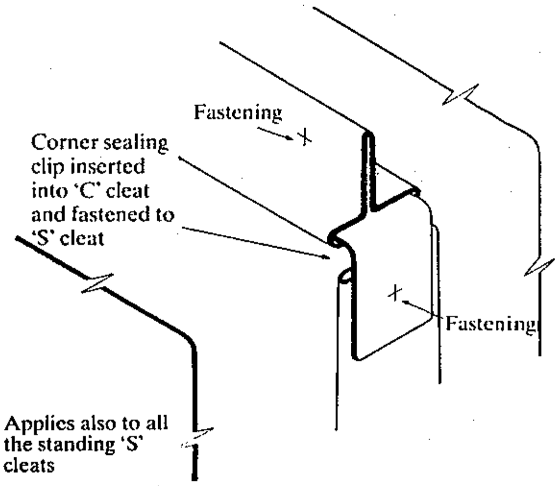


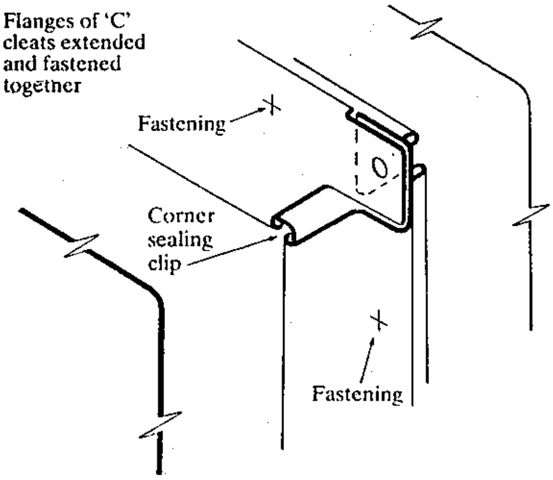
Fig. 31 Combination of standing 'C' cleat and 'S' cleat



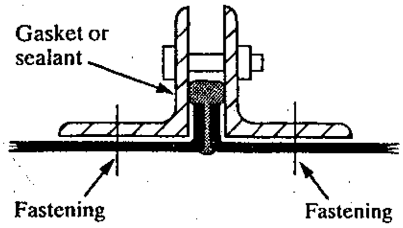
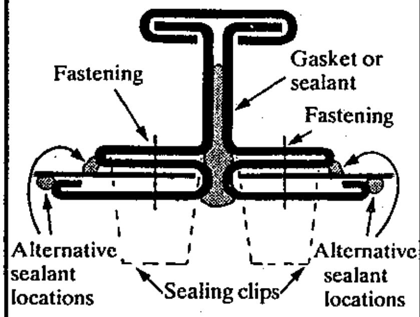
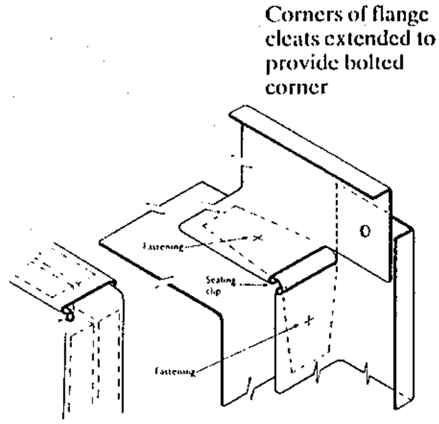
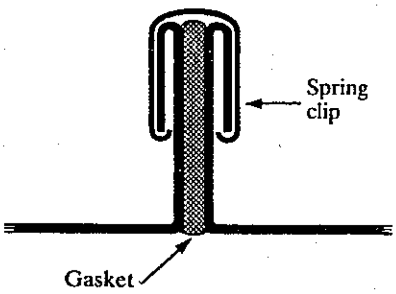
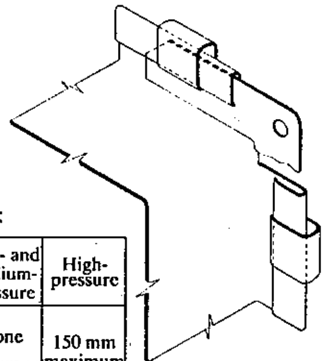
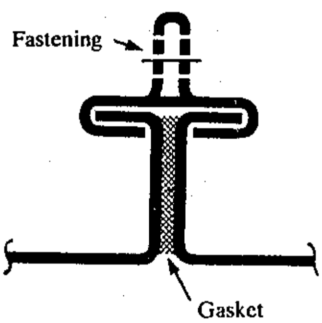
Applies also to all the standing 'S' cleats

Fig. 32 Standing 'C' cleat
(alternative corner treatment to Fig. 30)

Flanges of 'C' cleats extended and fastened together

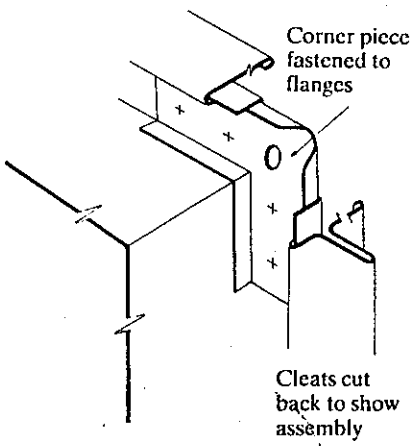


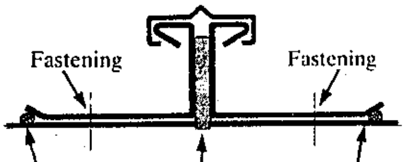
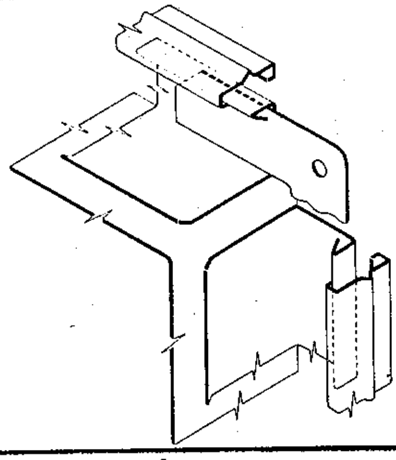
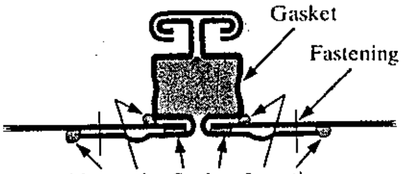
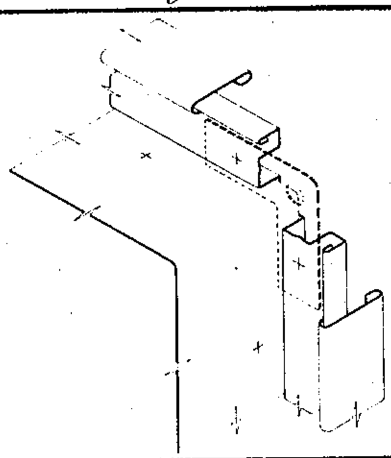
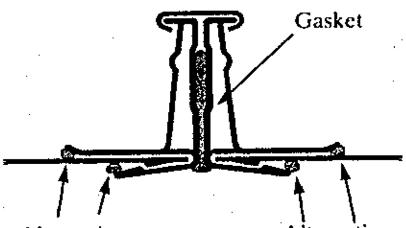
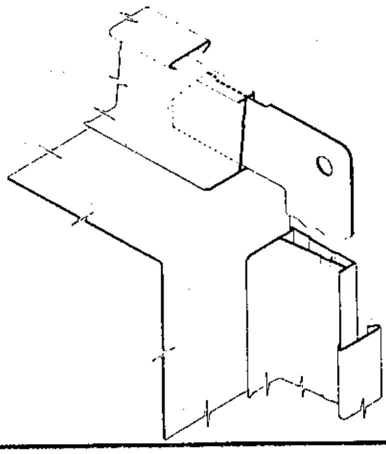
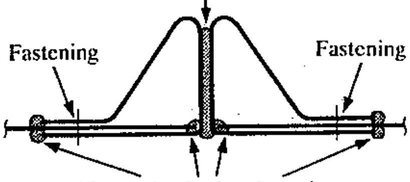
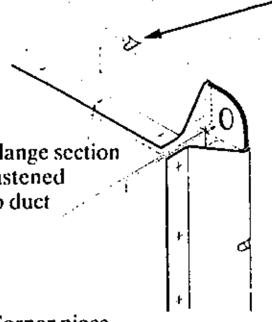
Flanged cross joints

<table>
<tr><th>Type</th><th>Dimensions</th><th>Rating</th><th>Pressure classes</th><th>Notes/corner treatments</th></tr>
<tr><td>Fig. 33 Rolled steel angle-flanged joint, with welded corners

</td><td>mm
25 x 3
30 x 4
40 x 4
50 x 5</td><td>J3
J4
J5
J6</td><td>Low
Medium
High</td><td>Duct ends turned up 10 mm.
Fixing bolts required at each corner and intermediately at 150 mm centres.</td></tr>
<tr><td>Fig. 34 Reinforced flange cleat with 'C' cleat

</td><td>40 x 0.8</td><td>J3</td><td>Low
Medium</td><td>
</td></tr>
<tr><td>Fig. 35 Integral flange with spring clips

</td><td>18 high</td><td>J1</td><td>Low
Medium
High</td><td>
Spring clips:
<table><tr><th>Duct size (longer side)</th><th>Low- and medium-pressure</th><th>High-pressure</th></tr><tr><td>Up to 300 mm</td><td>None</td><td rowspan="2">150 mm maximum centres</td></tr><tr><td>Over 300 up to 1000 mm</td><td>300 mm maximum centres</td></tr></table></td></tr>
<tr><td>Fig. 36 Integral standing flanged with 'C' cleat or standing 'C' cleat

</td><td>With plain cleat 25 high

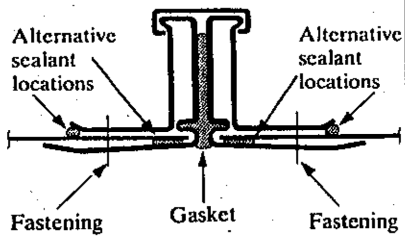
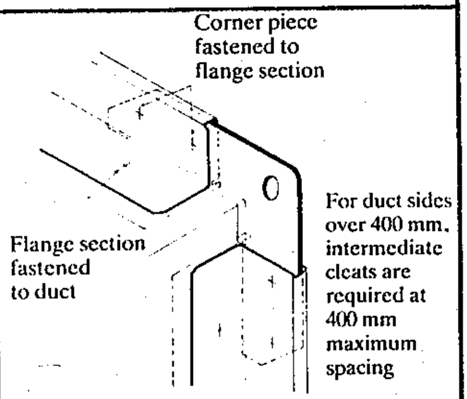
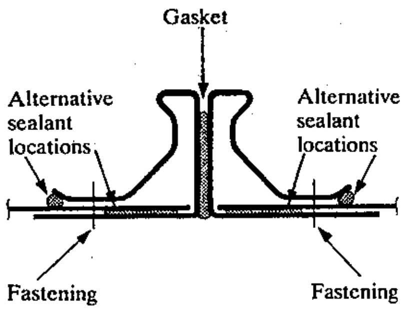
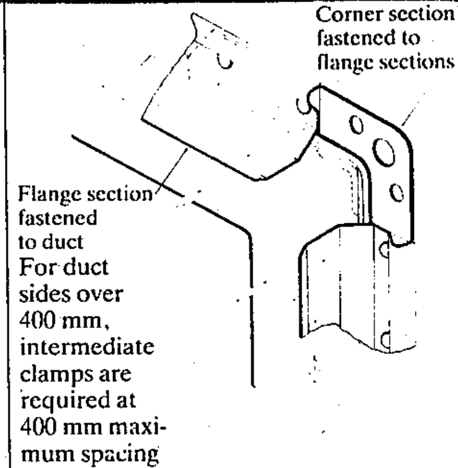
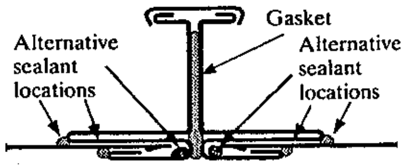
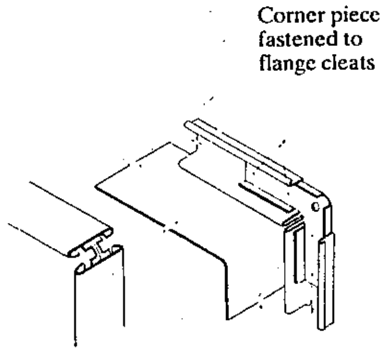
With standing cleat 46 high</td><td>J2

J3</td><td>Low
Medium
High

Low
Medium
High</td><td>
</td></tr>
</table>

Type	Dimen-sions	Rating	Pressure classes	Notes/corner treatments
Fig. 37 Attached flange  	25 x 0.8	J2	Low Medium	
Fig. 38 Slide-on flange with integral gasket  	24 x 0.8 24 x 1.6	J2 J3	Low Medium Low Medium	
Fig. 39 Button lock flange  	25 x 0.8	J2	Low Medium	
Fig. 40 Slide-on flange with integral sealant  	26 x 0.9 35 x 0.9 35 x 1.5	J1 J2 J3	Low Medium Low Medium Low Medium High	 For duct sides over 400 mm, intermediate clamps are required at 400 mm maximum spacing

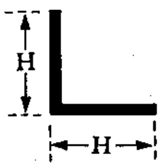
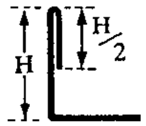
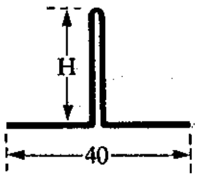
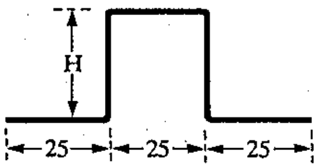
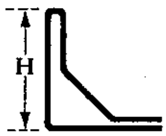
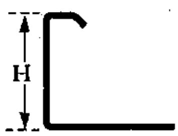
Flanged cross joints *(continued)*

Type	Dimen-sions	Rating	Pressure classes	Notes/corner treatments
Fig. 41 Slide-on flange 	20 x 0.8 30 x 1.0 40 x 1.25 40 x 1.25	J2 J3 J4 *J5	Low Medium High	
Fig. 42 Slide-on flange 	20 x 0.8 30 x 1.0 40 x 1.25 40 x 1.25	J2 J3 J4 *J5	Low Medium High	
Fig. 43 Button lock flange 	25 x 1.0 25 x 1.0	J3 *J4	Low Medium	

* With central tie bar

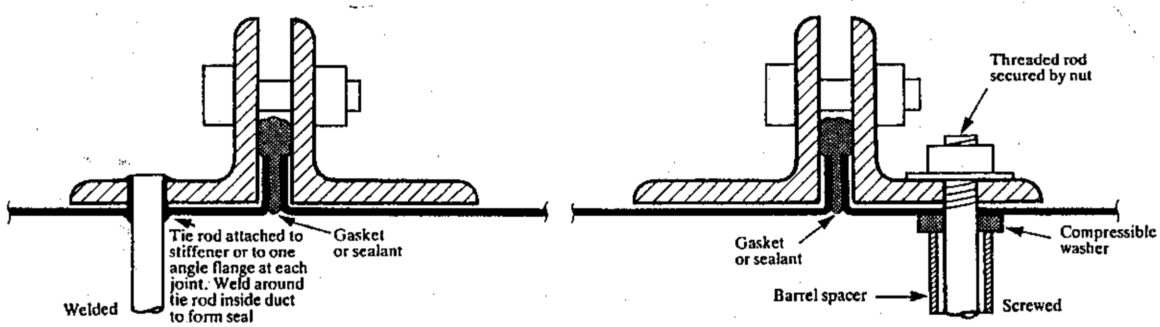
Single stiffeners

Dimensions and ratings

Section	H mm	Thickness mm	Rating
Fig. 44 	25	3	S2
	30	4	S3
	40	4	S4
	50	5	S5
	60	5	S6
Fig. 45 	25	1.6	S1
	30	1.6	S2
	40	1.6	S3
	50	2.0	S4
Fig. 46 	20	1.6	S1
	25	1.6	S2
	35	1.6	S3
	40	2.0	S4
Fig. 47 	15	1.2	S1
	20	1.2	S2
	25	1.6	S3
	40	1.6	S4
	50	2.0	S5
Fig. 48 	20	0.8	S1
	30	1.0	S2
	40	1.2	S3
Fig. 49 	25	0.8	S1

Note – Figs. 48 and 49 are notional profiles of sections suitable for use as intermediate stiffeners

Fig. 50 Tie rods (alternative methods)



Note–Tie rods illustrated in Figs. 118 to 120 (page 52) are also suitable.

11 FITTINGS

11.1 Standardisation of fittings

The names and descriptions of rectangular duct fittings as set out in Table 11 are recommended for adoption as standard practice, as being in the interests of designers, quantity surveyors and ductwork contractors, and of those using computers in ductwork design and fabrication.

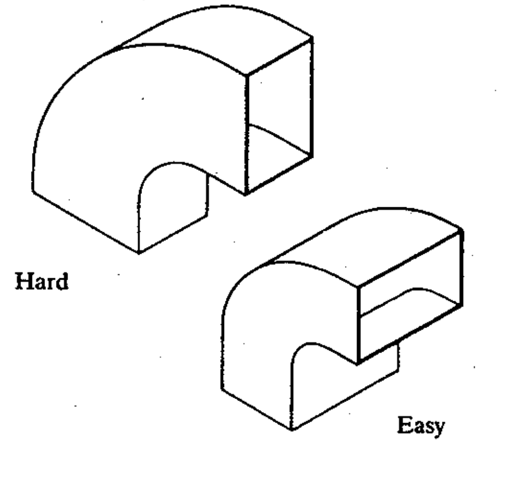
Bends are designated as 'hard' or 'easy', and these terms as used herein have the following meanings:

'Hard' signifies rotation in the plane of the *longer* side of the cross section.

'Easy' signifies rotation in the plane of the *shorter* side of the cross section.

An example illustrating these terms is given in Fig. 51.

Fig. 51 Bends – examples of 'hard' and 'easy'



11.2 General constructional requirements

The minimum metal thicknesses specified in Table 4 apply to duct fittings. In all cases the larger dimension shall determine the sheet thickness and stiffening. Where fittings are to be galvanized after manufacture, the requirements of Table 9 will apply.

11.3 Stiffeners

The flat sides of fittings shall be stiffened in accordance with the construction tables 5 to 8. On the flat sides of bends, stiffeners shall be arranged in a radial pattern, with the spacing measured along the centre line of the bend.

11.4 Splitters

Splitters shall be attached to the duct by bolts or mechanically-closed rivets (or by such other fixing as can be shown to be equally satisfactory) at 100 mm maximum spacing.

11.5 Turning vanes

Square bends shall be fitted with turning vanes, which shall be securely attached at each end either to the duct or to internal runners and the runners fastened to the duct by mechanically-closed rivets or bolts at 150 mm maximum spacing.

For **single-skin vanes**, the maximum length between supports shall be 615 mm, and for **double-skin vanes** the maximum length between supports shall be 1250 mm.

The recommended minimum number of turning vanes is given by the formula:

$$\text{No.} = \frac{1.5W}{r} \quad \textit{(see Fig. 55)}$$

An inner face radius of 50 mm is commonly used, and Table 12 gives the minimum number of such vanes for the standard widths of rectangular ducts set out in Table 3.

11.6 Twin bends

For examples of twin bends, see Figs. 56 to 58. Turning vanes in twin bends in which the widths of the straight section and branch differ shall be set so that the leading and the trailing edges of the turning vanes are parallel to the duct axes.

11.7 Branches

A branch should be taken off a straight section of duct, not off a taper. Branches should be connected to the main duct as follows:

11.7.1 Branches for low- and medium-pressure ducts

Connection of branch to duct may be by cleats, rivets or bolts, and sealant shall be used between duct and branch.

11.7.2 Branches for high-pressure ducts

Ducts shall be stiffened as necessary to take the branch connections, and the joints made by rivets or bolts, with sealant between duct and branch.

11.7.3 Welding

As an alternative to the methods described in 11.7.1 and 11.7.2, branch connections may be continuously welded.

11.8 Change shapes

Where a change shape is necessary to accommodate the duct and the cross-sectional area is to be maintained (Fig. 72), the slope shall not exceed 22½° on any side. Where a change in shape includes a local reduction in cross-sectional area (Fig. 73), the slope should not exceed 15° on any side and the reduction in area should not exceed 20 per cent.

11.9 Expansions and contractions

Where these are required, an expansion shall be made upstream of a branch connection and a contraction downstream of a branch connection. The slope of either an expansion or a contraction should not exceed 22½° on any side. Where this angle is not practicable, the slope may be increased, providing that splitters (Fig. 68) are positioned to bisect the angle between any side and the centre line of the duct.

11.10 Sealant

Sealant shall be used in all longitudinal seams and cross joints of fittings. Sealant shall be to the requirements of Section 27.

Table 11 RECTANGULAR DUCT FITTINGS – STANDARD NAMES AND DESCRIPTIONS

Name and description	Fig. No.
1	*2*
Bends	
Short radius – 'W' up to 300 mm all angles	52(a)
Short radius – 'W' over 300 mm (all angles)	52(b)
Medium radius (all angles)	53
Long radius (all angles)	54
Square (with turning vanes)	55
Twin radius – equal (all angles)	56
Twin radius – unequal (all angles)	57
Twin square (with turning vanes)	58
Branch (all angles)	59
Branches	
Rectangular or circular (90°)	60
Rectangular or circular (all angles other than 90°)	61
Shoe (rectangular or circular)	62
Shoe (high pressure) – rectangular	63
Offsets	
Angled	64
Mitred	65
Radiussed	66
Tapers	
Concentric (without splitters)	67
Concentric (with splitters)	68
Eccentric	69
Transformations	
Rectangular to circular (concentric)	70
Rectangular to circular (eccentric)	71
Change shapes	
Cross-sectional area retained	72
Cross-sectional area reduced	73

Part Three – Fittings for rectangular ducts

For sealing requirements, see Sec. 11.10 (page 33)

Bends

Fig. 52(a) Short radius – 'W' up to 300 mm (all angles)

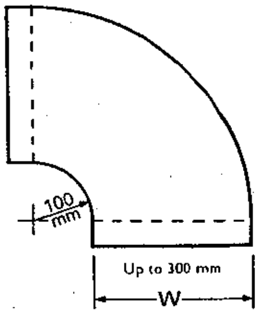
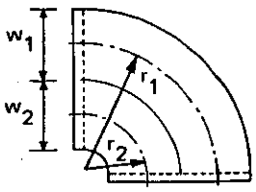


Fig. 52(b) Short radius – 'W' over 300 mm (Splitters not applicable to bends under 45°)



Splitters should be positioned so that the r/W ratio for each air passage is preferably above 1.5, with a minimum of 1.25.

Example with a minimum throat radius (100 mm):

W	Number of splitters
mm	
Up to 300	None
Over 300 up to 500	1
Over 500 up to 1000	2
Over 1000	3

Fig. 53 Medium radius (all angles)

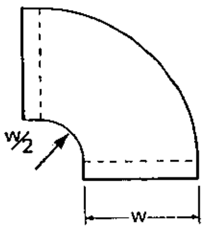


Fig. 54 Long radius (all angles)

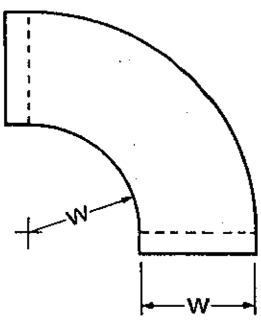


Fig. 55 Square

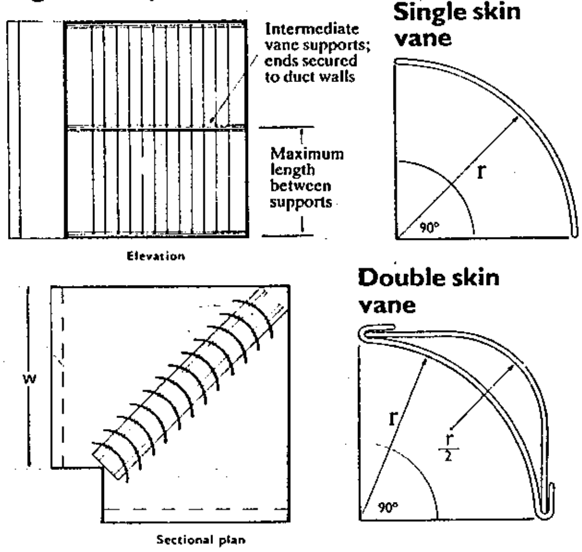


Table 12 Number of turning vanes

r = 50 mm	
Width of duct 'W'	Minimum number of turning vanes: double or single-skin
1	*2*
mm	
250	6
300	9
400	12
500	15
600	18
800	24

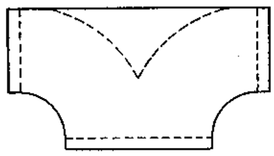


Fig. 56 Twin radius – equal (all angles)*

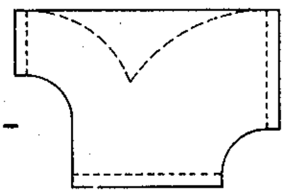


Fig. 57 Twin radius – unequal (all angles)*

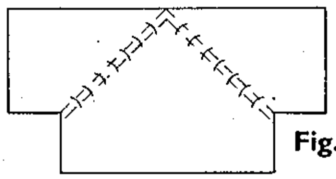
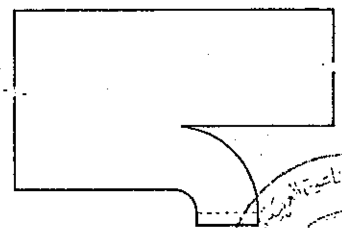


Fig. 58 Twin – square

Fig. 59 Branch (all angles)



*Splitters in accordance with Figs. 52(a) and (b)

Branches

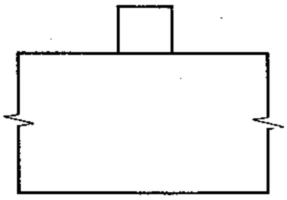


Fig. 60 90° branch (rectangular or circular)

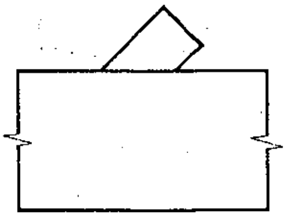


Fig. 61 Angled branch (rect. or circ.) – all angles other than 90°

Branch duct width (W)	Dimensions (A)
mm	mm
Up to 200	75
,, 300	100
,, 400	125
,, 600	150
Over 600	200

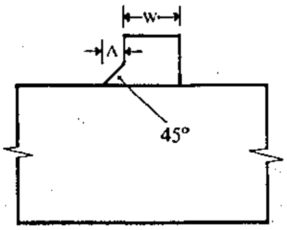


Fig. 62 Shoe branch (rect. or circ.)

Main duct opening (longer side)	Flat bar backing straps
mm	
Up to 600	None
Over 600 up to 1000	Internal only
Over 1000	Internal and external

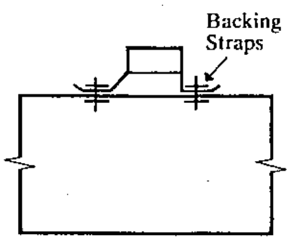


Fig. 63 Shoe branch (rectangular) – high-pressure

Offsets

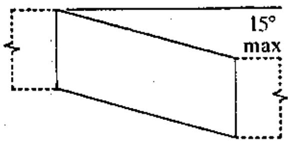


Fig. 64 Angled

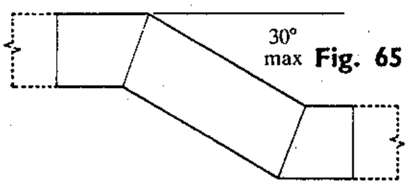


Fig. 65 Mitred

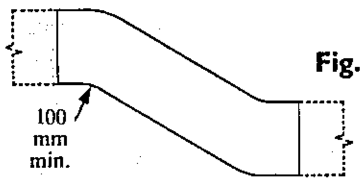


Fig. 66 Radiussed

Tapers

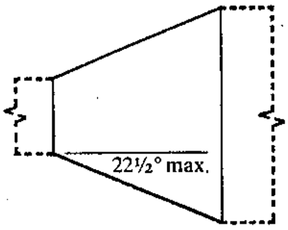


Fig. 67 Concentric – without splitters

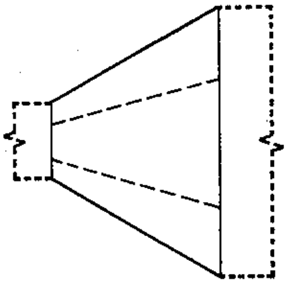


Fig. 68 Concentric – with splitters

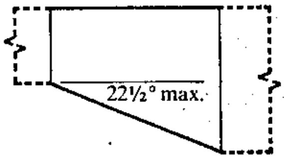


Fig. 69 Eccentric

Transformations

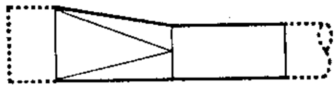


Fig. 70 Rect. to circ. – eccentric

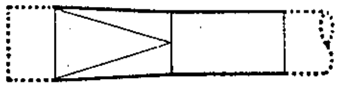


Fig. 71 Rect. to circ. – concentric

Change shapes

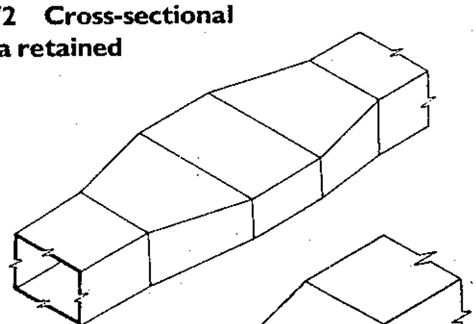


Fig. 72 Cross-sectional area retained

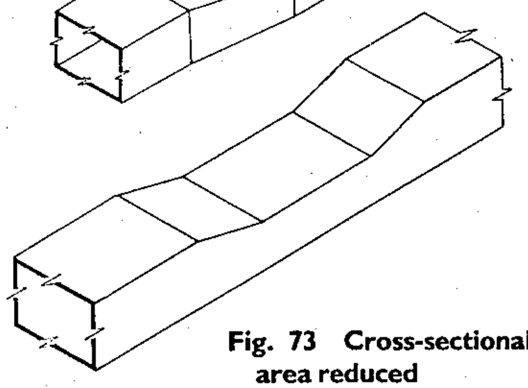


Fig. 73 Cross-sectional area reduced

Part Four – Circular Ducts

12 STANDARD SIZES

12.1 Two size ranges of circular ducts are in use in the UK: ISO and Imperial. For design purposes the same surface area, flow rate and frictional resistance may be used for each corresponding size.

Col. 1 of Table 13 sets out the standard sizes accepted by the International Standards Organisation for conversion into an ISO standard; and Col. 2 gives the nearest Imperial size equivalent.

Table 13 Circular ducts – standard sizes

ISO standard sizes (nominal diameter	Nearest Imperial size (nominal diameter)	Surface area per metre length (ISO sizes only)
1	2	3
mm	mm	Sq. metres
63	64	0.198
71	76	0.223
80	–	0.251
90	89	0.283
100	102	0.314
112	–	0.352
125	127	0.393
140	133	0.440
160	152	0.502
180	178	0.566
200	203	0.628
224	229	0.704
250	254	0.785
280	279	0.880
315	305	0.990
355	356	1.115
400	406	1.257
450	457	1.413
500	508	1.571
560	559	1.760
630	610	1.979
710	711	2.229
800	813	2.512
900	914	2.826
1000	1016	3.142
1120	1118	3.517
1250	1270	3.927

Note. The above sizes are subject to the normal manufacturing tolerances.

13 CONSTRUCTION

13.1 Spirally-wound ducts
The minimum constructional requirements set out in Table 14 are common to the full range of pressures covered in this specification. The method of forming the duct and the specified cross joints make additional stiffening unnecessary.

13.2 Straight-seamed ducts
Table 15 gives the differing minimum requirements according to the pressure classification. All straight-seamed circular ducts shall be manufactured with a swage not less than 40 mm or more than 75 mm from each end, unless a reinforcing angle ring is fitted.

If straight-seamed circular ducts are required to be galvanized after manufacture, the sheet thickness used for such ducts shall be a minimum of 1.2 mm, irrespective of the size of the duct; and cross joints shall in all cases be angle flanged.

13.3 Longitudinal seams

13.3.1 Spirally-wound ducts
The grooved seam used in spirally-wound circular ducts, provided it is tightly formed to produce a rigid duct, is accepted as airtight to the requirements of all the pressure classifications covered in this specification, without sealant in the seam.

13.3.2 Straight-seamed ducts
The longitudinal seam for straight-seamed circular ducts shall be either the grooved seam (Fig. 74), continued to the extreme end of the duct and sealed during manufacture; or a continuous butt or lap weld, provided this gives a smooth internal finish.

13.4 Cross joints

13.4.1 General
Cross joints for circular ducts, both spirally-wound and straight-seamed, are illustrated in Figs. 75 to 86. They include several proprietary types and the limits of use in terms of diameter and pressure classes are noted against each.

13.4.2 Sealant/welding
Sealant shall be used in all circular duct cross joints, whether the ducts are spirally-wound or straight-seamed. Alternatively, such cross joints shall be continuously welded. (However, the synthetic rubber gaskets incorporated in joints Figs. 80 and 81 are regarded as providing an effective sealant for those joints.)

The use of chemical-reaction tape or heat-shrinkable band shall be regarded as an effective sealant in respect of the socket and spigot joints illustrated.

13.4.3 Socket and spigot joint without gasket
Where the joint is made with sealant, the ends to be joined shall either be carefully cleaned with a suitable solvent to a length of 100 mm and sealant applied to the spigot so as to give a joint length in accordance with Table 18, or, sealant shall be applied in the alternative position indicated in figures nos. 75, 76, 77, 82, 83 and 84. Use of excessive sealant shall be avoided. The joint shall be held in place by a minimum of three permitted fastenings.

Where the joint is made by enclosure, such as with a chemical-reaction tape, heat-shrinkable band or strap, or other approved material, the maker's instructions shall be followed.

13.4.4 Flanged joints
The duct end shall be turned up approximately 10 mm. Alternatively, the duct shall be continuously welded inside the angle flange. Sealant or gasket shall be used between the angle flanges.

13.4.5 Welded joints
The limitations for welded joints are given in 13.5.5.

Table 14 SPIRALLY-WOUND DUCTS

Maximum (nominal) diameter	Minimum sheet thickness	Minimum stiffening requirements
1	*2*	*3*
mm	mm	
205	0.6	None
762	0.8	None
914	1.0	None
1020	1.0	None if tube is also helically beaded. If *factory made:* Fig. 75; if *site made:* Fig. 77 (angle reinforced) or Fig. 78 or 79 (angle flanged) – all at 3000 mm maximum spacing.
1525	1.2	Figs. 78 and 79 at 3000 mm maximum spacing.

Table 15 STRAIGHT-SEAMED DUCTS

Maximum (nominal) diameter	Minimum sheet thickness		Minimum stiffening requirements
	Low– and medium–pressure	High–pressure	
1	*2*	*3*	*4*
mm	mm	mm	
205	0.6	0.8	Swaged at both ends of all joints
510	0.8	0.8	
762	0.8	1.0	
1020	1.0	1.2	Swaged at both ends of all joints; 30 x 3 mm angle rings at 1250 spacing
1525	1.2	1.2	40 x 4 mm angle rings at 1250 mm spacing

13.5 Fastenings

13.5.1 Permitted types and maxmum centres

Table 16 sets out the permitted fastenings and maximum spacings for low-, medium- and high-pressure ducts. All duct penetrations shall be sealed.

13.5.2 Rivets

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

13.5.3 Bolts and nuts

Bolts and nuts shall be of mild steel, protected by electro-galvanizing, Sherardizing, cadmium-plating or other equal and approved finish.

13.5.4 Self-tapping screws

Self-tapping screws, while not recommended, are acceptable in circumstances in which the use of other types of fastening is not practicable.

13.5.5 Welding of sheet

The suitability of welding for sheet-to-sheet fastening will be governed by the sheet thickness, the size and shape of the duct or fitting and the need to ensure airtightness. Welded joints shall provide a smooth internal surface and shall be free from porosity. Distortion shall be kept to a minimum.

Areas where the galvanizing has been damaged or destroyed by welding or brazing shall be suitably prepared and painted internally and externally with zinc-rich or aluminium paint.

14 FITTINGS

14.1 Standardisation of fittings

The names and descriptions of circular duct fittings as set out in Table 19 are recommended for adoption as standard practice, as being in the interests of designers, quantity surveyors and ductwork contractors, and of those using computers in ductwork design and manufacture.

The requirements for circular duct fittings apply throughout the pressure ranges covered in this specification.

14.2 Nominal diameters

The nominal diameter (see Table 13) is the size used for design and ordering. With socket and spigot joints, care should be taken to ensure that the dimensions of the ducts and fittings are correctly related, so that the joint can be effectively sealed.

14.3 Sheet thickness

Sheet thicknesses for circular duct fittings (determined by the largest diameter) shall be not less than those quoted in Table 17.

14.4 Socket and spigot joints

The minimum length of spigots are set out in Table 18. Fittings larger than 510 mm diameter shall have swaged ends.

14.5 Sealing of joints

Sealant shall be used in all cross joints of fittings. Such sealant shall be in accordance with the requirements of Section 27.

Table 16 Permitted fastenings and maximum spacings–circular ducts

Type of fastening	Sheet to sheet (cross joints)	Sheet to section (cross joint flanges and intermediate stiffening flanges)	
		Spirally-wound	Straight seamed
1	*2*	*3*	*4*
		mm	mm
Mechanically closed rivets	300 mm centres (minimum three)	150	150
Bolts and nuts	—	—	300
Lock bolts	—	—	300
Spot welds	—	—	150

Table 17 Circular duct fittings–sheet thicknesses

Maximum nominal diameter	Minimum sheet thickness
1	*2*
mm	mm
160	0.6
510	0.7
630	0.8
1020	1.0
1525	1.2

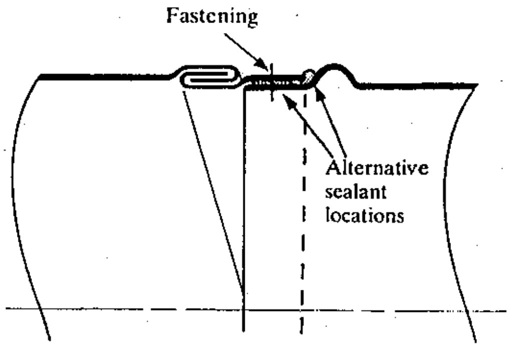
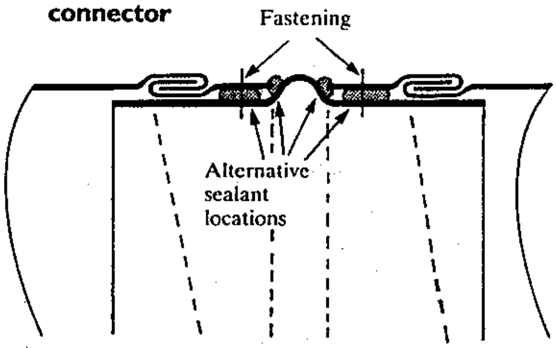
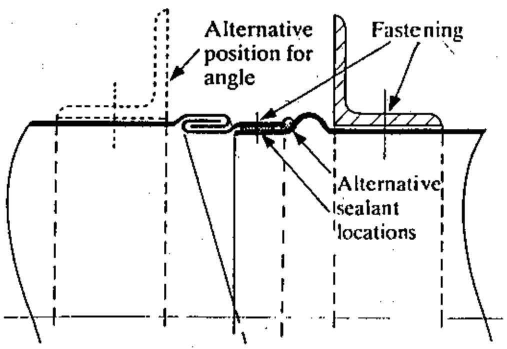
Table 18 Circular duct fittings–spigots

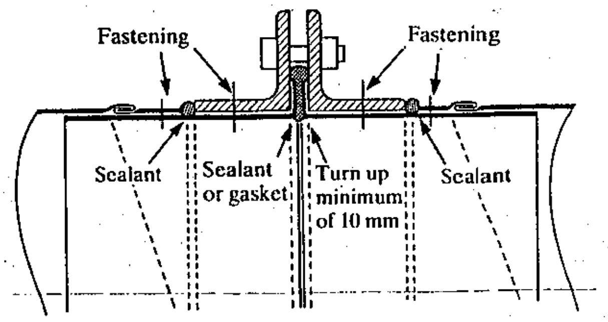
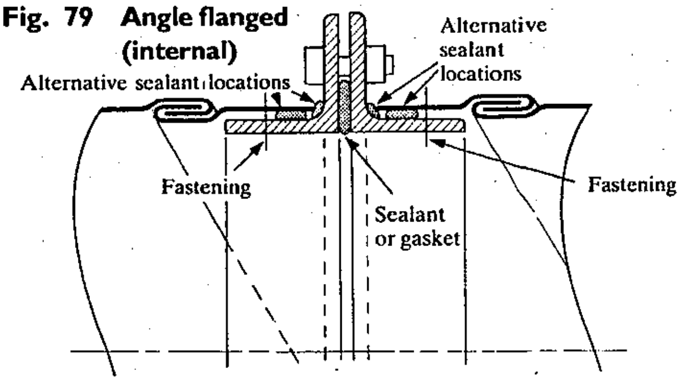
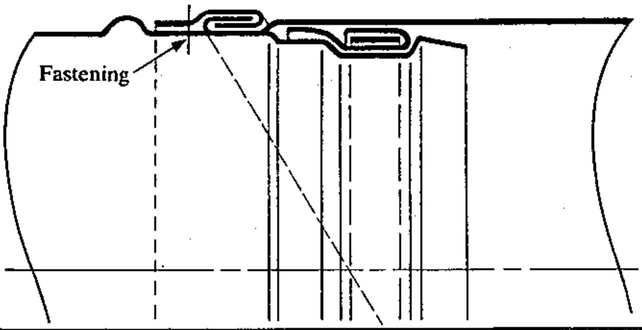
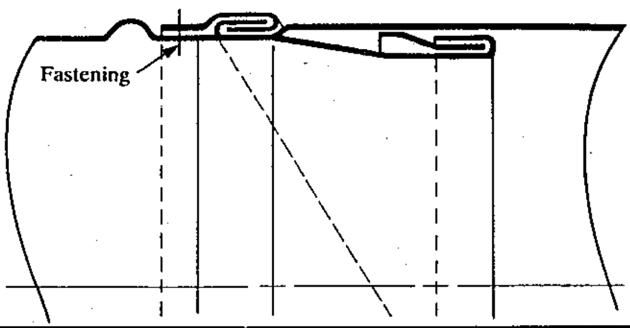
Maximum duct diameter	Minimum length of spigot
1	*2*
mm	mm
Fittings	
160	30
315	40
1525	50
Closures	25

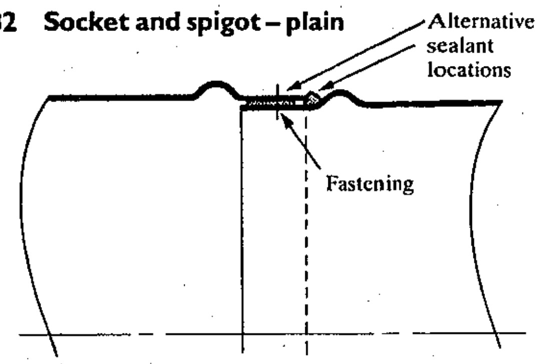
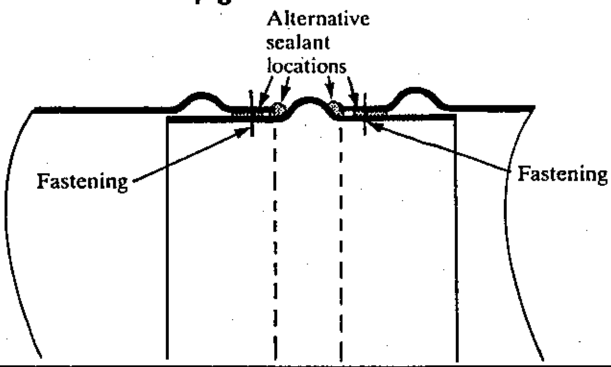
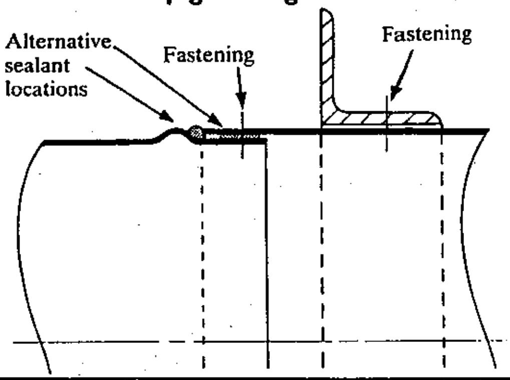
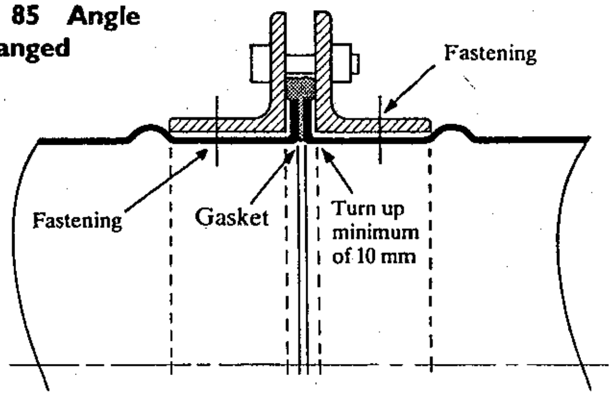
Fig. 74 Grooved seam (straight-seamed ducts)

Circular duct cross joints

Note – All duct penetrations shall be sealed

Spirally-wound ducts	Limits of use: Angle size	Limits of use: Maximum diameter	Limits of use: Pressure classes
	mm	mm	
Fig. 75 Plain socket and spigot (duct to fitting) 	–	1020	Low Medium High
Fig. 76 Socket and spigot (duct to duct) with connector 	–	1020	Low Medium High
Fig. 77 Angle reinforced socket and spigot with connector 	*25 x 3 *30 x 3 40 x 4	762 1020 1525	Low Medium High
	*Where angle rings specified		

<table>
<tr><th rowspan="2">Spirally-wound ducts</th><th colspan="3">Limits of use</th></tr>
<tr><th>Angle size</th><th>Maximum diameter</th><th>Pressure class</th></tr>
<tr><td>Fig. 78 Angle flanged (external)

</td><td>*25 x 3
*30 x 3
40 x 4</td><td>762
1020
1525</td><td>Low
Medium
High</td></tr>
<tr><td></td><td colspan="3">*Where flanged joints are specified</td></tr>
<tr><td>Fig. 79 Angle flanged (internal)

</td><td>*30 x 3
40 x 4</td><td>1020
1525</td><td>Low
Medium
High</td></tr>
<tr><td></td><td colspan="3">*Where flanged joints are specified</td></tr>
<tr><td>Fig. 80 Socket and spigot with synthetic rubber double gasket

</td><td>Not suitable for helically beaded spiral tube</td><td>1020</td><td>Low
Medium</td></tr>
<tr><td>Fig. 81 Socket and spigot with synthetic rubber single gasket

</td><td>Not suitable for helically beaded spiral tube</td><td>1020</td><td>Low
Medium</td></tr>
</table>

Straight-seamed ducts	Limits of use		
	Angle size	Maximum diameter	Pressure class
Fig. 82 Socket and spigot – plain 	mm	mm 800	Low Medium High
Fig. 83 Socket and spigot with connector 		800	Low Medium High
Fig. 84 Socket and spigot – angle reinforced 	*25 x 3 *30 x 3 40 x 4	762 1020 1525	Low Medium High
	*Only where angle ring specified		
Fig. 85 Angle flanged 	*25 x 3 30 x 3 40 x 4	762 1020 1525	Low Medium High
	*Only where flanged joint specified		

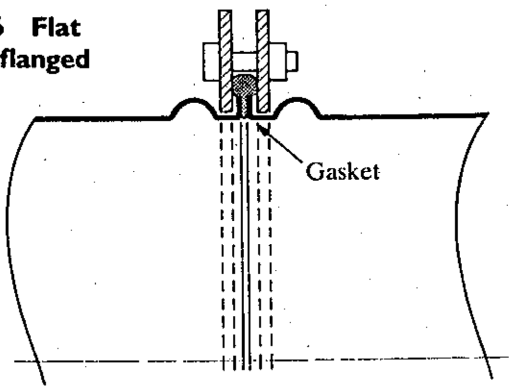
Straight-seamed ducts	Limits of use		
	Size of flat	Maximum diameter	Pressure class
Fig. 86 Flat ring flanged 	mm 25 x 3 30 x 3 40 x 5	mm 610 1020 1525	Low Medium

Table 19 CIRCULAR DUCT FITTINGS – STANDARD NAME AND DESCRIPTIONS

Name and description	Fig. No.
1	*2*
Bends	
Segmented - five section 90°	87
Segmented - four section 60°	88
Segmented - three section 45°	89
Segmented - two section 30°	90
Pressed – medium radius	91
Pressed – long radius	92
Pressed – twin radius (all angles)	93
Branches	
Square	94
Angles (all angles less than 90°)	95
Conical	96
Bell mouth	97
Shoe	98
Tangential	99
Mitred	100
Change shapes	
Concentric taper	101
Eccentric taper	102
Transformations	
Circular to rectangular (concentric)	103
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Offsets	
Mitred	105
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Male	107
Female	108
Closures	
Plug end	109
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Part Four – Fittings for circular ducts

For sealing requirements, see Sec. 14.5 (page 39)

Bends (segmented)

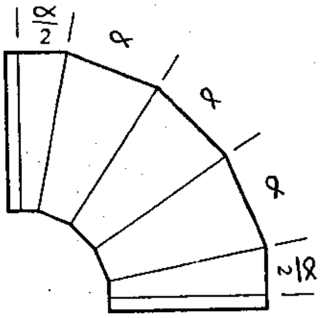


Fig. 87
Segmented – five-section 90° (also acceptable as a four-segment bend)

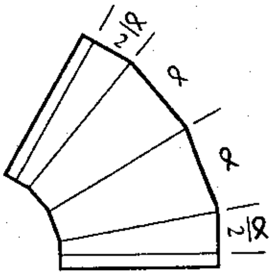


Fig. 88
Segmented – four-section 60°

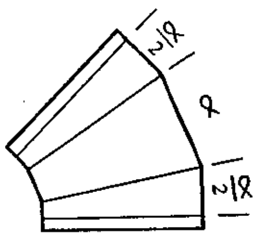


Fig. 89
Segmented – three-section 45°

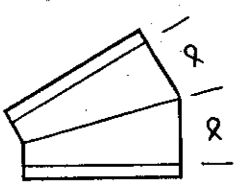


Fig. 90
Segmented – two-section 30°

Note – All segmented bends shall have a swage at each end.

Bends (radiussed) (½D or 1D throat radius)

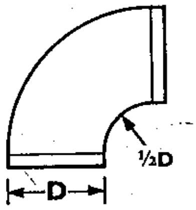


Fig. 91 Pressed – medium radius (available up to 400 mm)

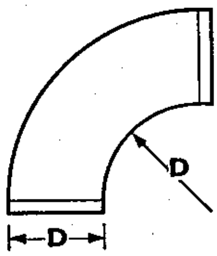


Fig. 92 Pressed – long radius (available up to 300 mm)

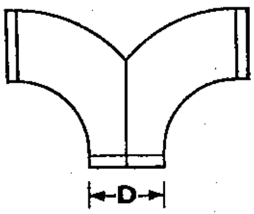


Fig. 93 90° twin radius (made from pressed bends Figs. 91 and 92)

Branches (as a connection off the duct or as a separate fitting)

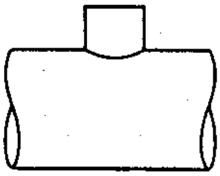


Fig. 94
Square

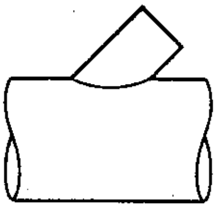


Fig. 95
Angled – all angles other than 90°

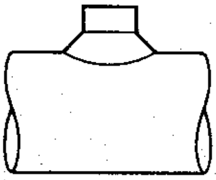


Fig. 96
Conical

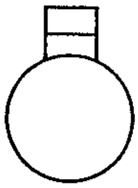


Fig. 97
Bell mouth

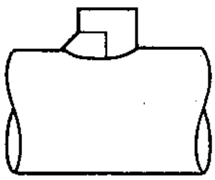


Fig. 98
Shoe

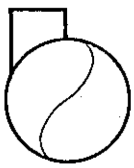


Fig. 99
Tangential

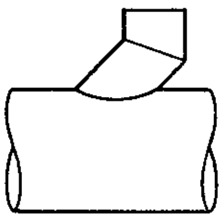


Fig. 100
Mitred

Change shapes

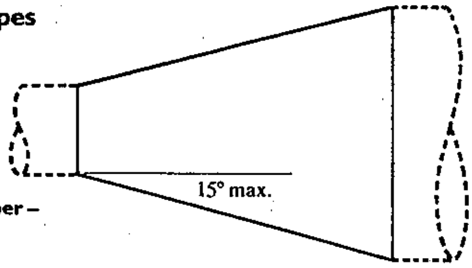


Fig. 101 Taper – concentric

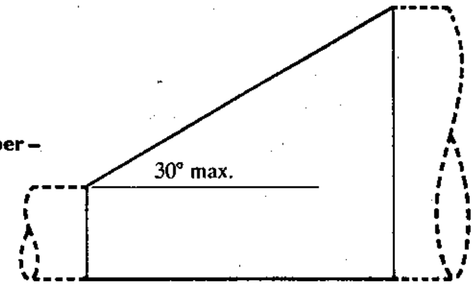


Fig. 102 Taper – eccentric

Transformations

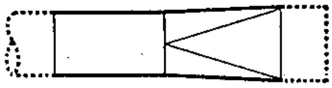


Fig. 103 Circular to rectangular – concentric

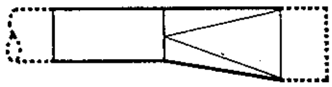


Fig. 104 Circular to rectangular – eccentric

Offsets

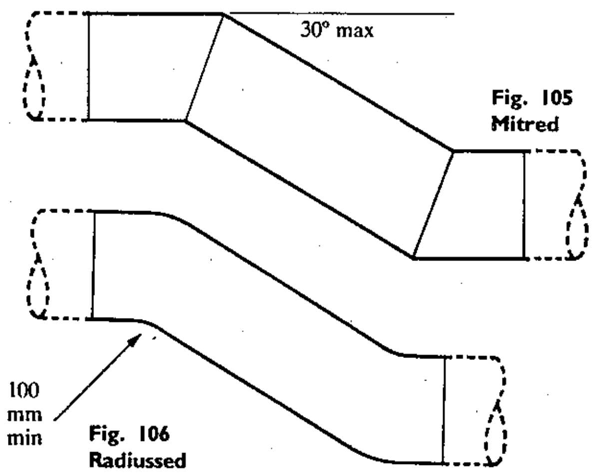


Fig. 105
Mitred

Fig. 106
Radiussed

Connectors

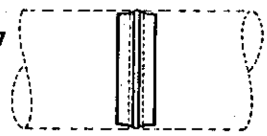


Fig. 107
Male

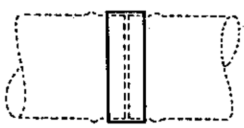


Fig. 108 Female

Closures

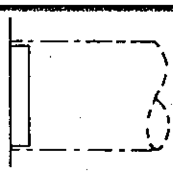


Fig. 109
Plug end

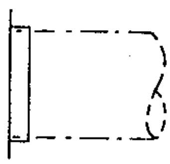


Fig. 110
Cap end

Part Five – Flat Oval Ducts

15 STANDARD SIZES AND SHEET THICKNESSES

15.1 Table 20 sets out the standard sizes of spirally-wound oval ducts offered by the manufacturers of ducts of this section.

Table 20 Flat oval ducts – Standard sizes and sheet thicknesses

Nominal sheet thickness	Surface area per metre length	Depth of duct (minor axis—'D')—nominal 75	100	125	150	200	250	300	350	400	450	500
1	*2*	*3*										
mm	sq. metres	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
		(Width of duct (major axis—'W')—nominal—mm)										
0.8	0.718	320										
	0.798	360	350	330	320							
	0.878	400	390	370	360							
	0.958	440	430	410	400							
	1.037	480	470	450	440							
	1.117	520	505	490	480							
	1.197		545	530	520							
	1.277	Swaged			555	525						
	1.436				635	605	580					
	1.596				715	690	660	630				
	1.756				800	770	740	710	685	655		
	1.915				880	845	825	790	765	735	705	680
1.0	2.075				960	930	900	875	845	815	785	755
	2.238				1040	1010	985	955	925	895	865	835
	2.394				1120	1090	1065	1035	1005	975	945	915
	2.553				1200	1170	1145	1115	1085	1055	1025	1000
	2.873					1335	1305	1275	1245	1215	1190	1160
	3.192						1465	1435	1405	1375	1350	1320
	3.511						1625	1595	1570	1540	1510	1480
	3.830						1785	1760	1730	1700	1670	1640

16 CONSTRUCTION

16.1 General

'Flat oval' is the term used to describe a duct of cross-section with flat opposed sides and semi-circular ends. The duct is formed from a spirally-wound circular duct, using a special former.

Apart from stiffening (for which see Tables 21 and 22), flat oval ducts have the same constructional requirements throughout the pressure ranges covered in this specification.

Flat oval ducts may also be formed from flat sheet with straight seams (see Section 17).

Table 21 – Flat oval ducts – low- and medium-pressure – stiffening requirements

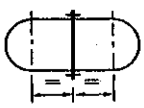
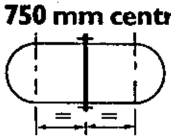
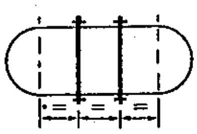
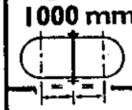
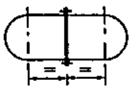
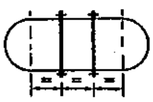
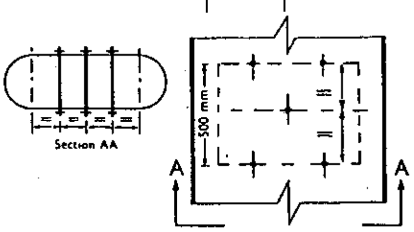
Tie rods	Depth of duct (minor axis—'D') – nominal: 75	100	125	150	200	250	300	350	400	450	500
1	*2*										
	Width of duct (major axis — 'W') — nominal — mm										
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Not required	320										
	360	350	330	320							
	400	390	370	360							
	440	430	410	400							
	480	470	450	440							
	520	505	490	480							
		545	530	520							
				555	525						
				635	605	580					
Fig. 111 **100 mm centres** 				715	690	660	630				
				800	770	740	710	685	655		
				880	845	825	790	765	735	705	680
Fig. 112 **750 mm centres** 				960	930	900	875	845	815	785	755
				1040	1010	985	955	925	895	865	835
				1120	1090	1065	1035	1005	975	945	915
Fig. 113 **500 mm centres** 				1200	1170	1145	1115	1085	1055	1025	1000
					1335	1305	1275	1245	1215	1190	1160
						1465	1435	1405	1375	1350	1320
						1625	1595	1570	1540	1510	1480
						1785	1760	1730	1700	1670	1640

Table 22 – Flat oval ducts – high-pressure – stiffening requirements

Tie rods	Width of duct (major axis — 'W') — nominal — mm	Depth of duct (minor axis—'D') – nominal 75	100	125	150	200	250	300	350	400	450	500
1		*2*										
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Not required		320										
		360	350	330	320							
		400	390	370	360							
		440	430	410	400							
		480	470	450	440							
		520	505	490	480							
			545	530	520							
Fig. 114 **1000 mm centres** 					555	525						
					635	605	580					
Fig. 115 **750 mm centres** 					715	690	660	630				
					800	770	740	710	685	655		
					880	845	825	790	765	735	705	680
Fig. 116 **500 mm centres** 					960	930	900	875	845	815	785	755
					1040	1010	985	955	925	895	865	835
					1120	1090	1065	1035	1005	975	945	915
					1200	1170	1145	1115	1085	1055	1025	1000
Fig. 117 						1335	1305	1275	1245	1215	1190	1160
							1465	1435	1405	1375	1350	1320
							1625	1595	1570	1540	1510	1480
							1785	1760	1730	1700	1670	1640

16.2 Longitudinal seams

Spirally-wound flat oval duct is accepted as airtight to the requirements of this specification without sealant in the seams, provided the grooved seam is tightly formed to produce a rigid duct.

16.3 Cross joints

Cross joints shall be as Figs. 75, 76 or 77, or such other joint as can be shown to the designer to be equally satisfactory.

Sealant, whether mastic, chemical-reaction tape or heat-shrinkable tape) shall be used in all cross joints.

16.3.1 Socket and spigot joints

Where the joint is made with sealant, the ends to be joined shall be carefully cleaned with a suitable solvent to a length of 100 mm and sealant applied to the spigot so as to give a joint length as for the requirements for circular ducts – see Table 18. Use of excessive sealant shall be avoided. The joint shall be fixed with permitted fastenings at 60 mm centres, on the flat surfaces only.

Where the joint is made by enclosure, such as with a chemical reaction tape, heat shrinkable band or strip, or other approved material, the maker's recommendations shall be followed. Care should be taken to maintain close contact between the material and the flat sides of the duct until the joint is completed.

16.3.2 Flanged joints

Where conditions require the use of flanged joints, they shall be as Fig. 78 or 79. Alternatively, the duct shall be continuously welded inside the angle flange. Sealant shall be used between the duct and the spigot, and sealant or gasket between the angle flanges. The flanged joint shall be secured by bolts and nuts at 150 mm centres.

16.4 Stiffening

The larger sizes of flat oval duct are stiffened by swages, as indicated in Table 20. Additionally, tie rods (see Figs. 118 to 120) are required, positioned as indicated in the respective tables and illustrations.

As an alternative to tie rods, stiffening in the form of external angles may be used to meet the requirements of the corresponding rectangular duct sizes.

17 CONSTRUCTION (STRAIGHT-SEAMED)

17.1 Flat oval ducts with opposed sides and semi-circular ends may also be formed using plain sheet and straight seams. Ducts so formed should follow the metal thicknesses and stiffening requirements specified for the corresponding sizes of rectangular ducts, except that stiffening is necessary on the flat sides only.

Seams and cross joints shall be sealed to ensure the necessary degree of airtightness throughout the pressure ranges covered in this specification.

18 FITTINGS

18.1 General constructional requirements

Sheet thicknesses for flat oval fittings (determined by the periphery of the larger end) shall be not less than those given in Table 20 for the ducts themselves.

With socket and spigot joints, care should be taken to ensure that the dimensions of ducts and fittings are correctly related.

All the seams and joints integral to a fitting shall be sealed to the same standard as the duct.

18.2 Standard fittings for flat oval ducts

Table 23 lists the basic forms and accepted names for the flat oval duct fittings; typical illustrations are given in Figs. 121 to 136. The basic forms, used in combination, will cover the full range of fittings for flat oval ducts.

Tie rod assembly – alternative arrangements

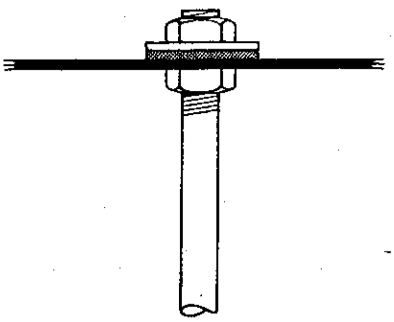


Fig. 118 With internal and external nuts

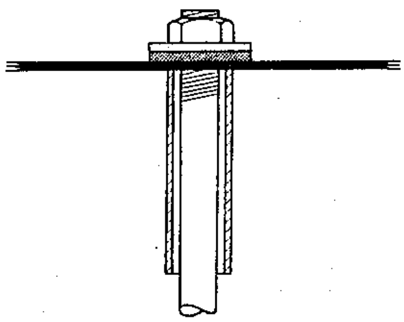


Fig. 119 With spacers

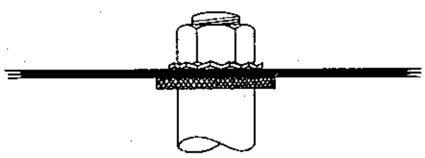


Fig. 120 With shouldered rod

Table 23 FLAT OVAL DUCT FITTINGS – STANDARD NAMES AND DESCRIPTIONS

Name and description	Fig. No.
Bends	
Segmented – five-section 90° (hard)	121
Segmented – five-section 90° (easy)	122
Segmented – three-section 45° (hard)	123
Segmented – three-section 45° (easy)	124
Square (hard) (rectangular body, flat oval ends)	125
Square (easy) (rectangular body, flat oval ends)	126
Square (hard)	127
Square (easy)	128
Twin	129
Branches	
For fittings off **flat profile,** see rectangular fittings, Figs. 60, 61 and 62	
For branches off **semi-circular profile,** see circular fittings, Figs. 94 to 100	
Tapers	
Reducer – concentric	130
Reducer – eccentric	131
Transformations	
Flat oval to circular	132
Flat oval to rectangular	133
Offset	
Mitred (hard or easy)	134
Coupling	135
Closure	136

Part Five – Fittings for flat oval ducts

For sealing requirements, see Sec. 18.1 (page 50)

Bends

Fig. 121
Segmented – five-section 90° (hard)

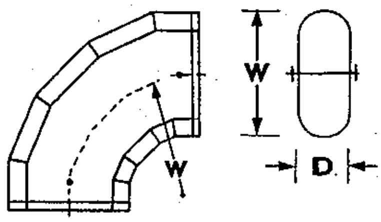


Fig. 122
Segmented – five-section 90° (easy)

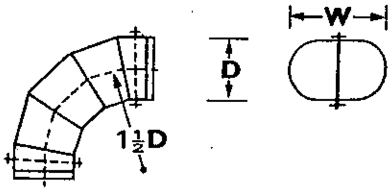


Fig. 123
Segmented – three-section 45° (hard)

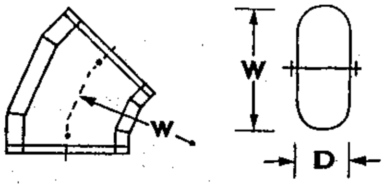


Fig. 124
Segmented – three-section 45° (easy)

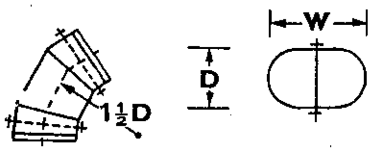


Fig. 125
Square (hard) (rect. body, flat oval ends)

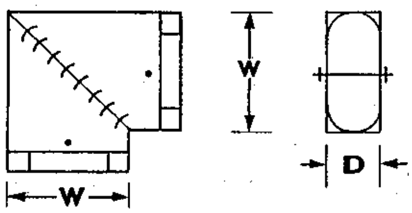


Fig. 126
Square (easy) (rect. body, flat oval ends)

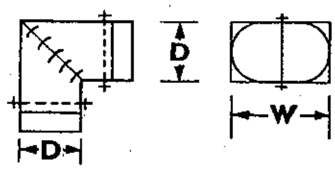


Fig. 127
Square (hard)

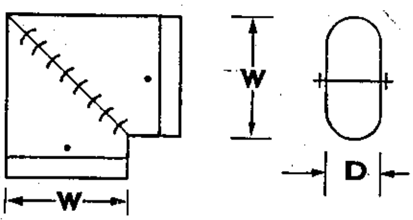
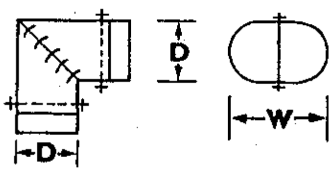
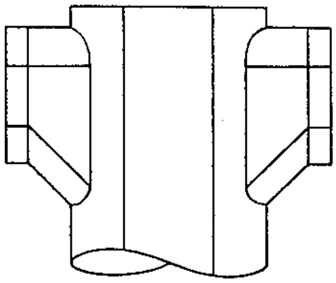


Fig. 128
Square (easy)



Bends (ctd)

Fig. 129
Twin



Tapers

Fig. 130
Reducer – concentric

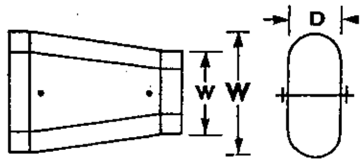
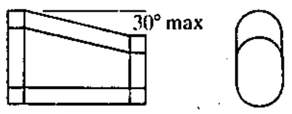


Fig. 131
Reducer – eccentric



Transformations

Fig. 132
Flat oval to circular

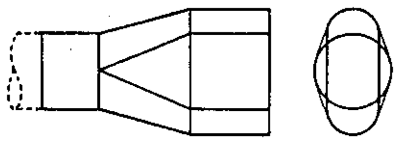
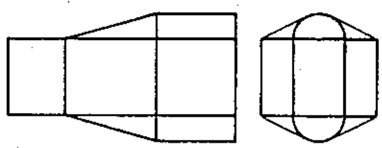
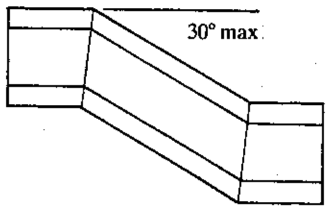


Fig. 133
Flat oval to rectangular



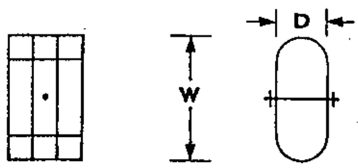
Offset

Fig. 134
Mitred (hard or easy)



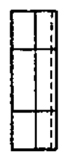
Coupling

Fig. 135



Closure

Fig. 136



Part Six – Hangers and Supports

19 GENERAL

19.1 Principles adopted

Supports are an essential part of the ductwork system, and their supply and installation are normally the responsibility of the ductwork contractor. The choice between the available methods of fixing will depend on the type of building structure and on any limitations imposed by the structural design. Further, unless the designer has specified his requirements in detail, the load to be carried shall be understood to be limited to the ductwork and its associated insulation.

It is not practicable to deal here with the full range of supports available, which increasingly includes proprietary types, so in this section various methods of support are dealt with in principle under the three elements of:

(1) the attachment to the structure;
(2) the hanger itself; and
(3) the duct support;

with illustrations of those most commonly used.

Special attention has been given to the treatment of supports for insulated ducts, with and without vapour sealing.

Supports for ductwork external to the building have been excluded, as these are individually designed to suit the circumstances, and also **may be required to meet local authority standards.** For the same reasons, floor supports have not been dealt with.

With a proprietary device, it will, unless the designer has specified his requirements in detail, be the responsibility of the ductwork installer to ensure that it meets requirements, with a sufficient margin of overload; and that it is installed in accordance with the manufacturer's recommendations.

The absence of any method or device from this specification does not preclude its use if it can be demonstrated that it is suitable for the duty assigned to it, with a sufficient margin of safety against overload; and this will be the responsibility of the ductwork installer, unless the designer has specified his requirements in detail.

19.2 Fixing to building structure

The fixing to the building structure should be of a strength and durability compatible with those of the ductwork support attached to it. A fixing to concrete or brickwork must be made in such a way that it cannot loosen or pull out through normal stressing or through normal changes in the building structure.

19.3 Horizontal ductwork

19.3.1 Attachment to structure

Attachments may be secured to the structure by means of an **expansion anchor** (Fig. 137) or **channel section** (Fig. 138). The use of the shot-fired type of bolt in a vertical position is not recommended as a support for a suspended load.

Where ducts are supported from walls, the bearing member is normally built into or attached to the wall and the duct suspended or supported therefrom.

Attachment to the building frame may be made by means of **beam clamps** (Fig. 139) or **spring clips** or **hooks** (Figs. 140). In addition, **spring clips adjustable for height** (Fig. 141) can be used with rod or studding.

While application and loading are the main factors in the choice of attachment, the consequences of dislodgement should be considered if those relying merely on friction, e.g. spring clips, are used.

19.3.2 The hanger itself

The hanger itself is usually mild steel **plain rod** or **studding** or **flat strap,** pre-treated by, e.g. hot-dip galvanizing, Sherardizing, electro-deposited zinc plating or by some other accepted anti-corrosion treatment. Other materials, such as **stranded wire,** may also be acceptable.

Projection of a rod or studding hanger through the bottom bearer should, where practicable, not exceed twice the thickness of the securing nut.

Provided the integrity of the ductwork is maintained, hangers may be attached to the corners of the flanges as an alternative to the use of a bottom bearer.

With proprietary devices manufacturers' recommendations for use should be followed.

19.3.3 The duct support

The choice of the lower support will be dictated by the actual duct section.

19.3.3.1 Rectangular ducts

Table 24 gives minimum dimensions for the hangers and for **angle, channel** and **profile sections.** The angle is shown in Fig. 142, the channel in Fig. 143 and the profile sections in Figs. 144 and 145.

Typical arrangements of bottom bearer supports for plain, insulated and vapour-sealed ducts are shown in Figs. 146 and 147. Alternative methods of support for such ducts, using

corner cleats, are shown in Figs. 148, and using **stirrup brackets** in Figs. 149 and 150.

19.3.3.2 Circular ducts

Table 25 gives minimum dimensions for the **hanger** and for the **brackets.** The three common methods of supporting circular ducts are: the **strap hanger** (Figs. 151 and 153 – limited to ducts with a diameter not exceeding 300 mm; the **half band clip** (Figs. 155 and 157); and the **split band clip** (Figs. 152 and 154).

19.3.3.3 Flat oval ducts

Table 26 gives the mininum dimensions for the hanger; and for the bearer, depending on whether the flat side of the duct is horizontal or vertical.

Typical arrangements for flat oval duct supports are shown in Figs. 156 and 158.

19.4 Vertical ducts

The design of supports for vertical ducts is dictated by site conditions, and they are often located to coincide with the individual floor slabs, subject to a maximum spacing of 4 metres.

Vertical ducts should be supported from the stiffening angle or the angle frame, or by separate supporting angles fixed to the duct.

A typical method of supporting vertical rectangular ducts is shown in Fig. 159 and for circular ducts in Fig. 160. The same methods are applicable to vertical flat oval ducts.

19.5 Heavy loadings

For ducts larger than those covered by Tables 24 to 26, or where heavy equipment, mechanical services, ceilings or other additional load is to be applied to the ductwork, supports shall be designed to suit the conditions.

19.6 Insulated ducts

Where ductwork is required to be insulated, this must be clearly specified, so that hangers are spaced to provide clearance for the insulation. Otherwise, supports may be as for uninsulated ductwork. Where fire regulations apply, approval of the relevant authority may be needed.

19.6.1 Insulated ducts with vapour sealing

Where the temperature of the air within the duct is at any time low enough to promote moisture penetration through the lagging and cause condensation on the exterior surface of the duct, vapour sealing may be called for, and in this case the most important requirement is to limit penetration of the seal.

The extent of any vapour sealing of ductwork, and the method to be used, must be clearly specified in advance, as follows:

Method 1

Where the risk of damage due to condensation is slight, the vapour seal can be applied to the insulated duct and made good round the supports to achieve an acceptable level of proofing.

Method 2

Where it is essential to keep penetration of the vapour seal to a minimum, supports should be external to the insulation, as shown in Figs. 147, 150, 154, 156, 157 and 158.

The insulation and vapour barrier should be abutted to the insulator incorporated with the duct support. This insulator shall be non-hygroscopic and shall be capable of carrying the imposed load without significant compression. Typical materials are hardwood or treated softwood (in separate block form for circular ducts); GRP (glass-reinforced plastics); and hard rubber compounds. Some proprietary systems of support for vapour-sealed ducts are available.

19.6.2 Heat transfer

It is not normally necessary to make special arrangements for the limitation of heat transfer via the duct supports. However, there may be special cases where the temperature difference justifies a heat barrier to conserve heat or to prevent condensation.

Table 24 Supports for horizontal ducts – rectangular

Maximum duct size (longer side)	Hanger		Bearing member			Maximum spacing of hanger
	Rod or studding (two) (dia.)	Flat strap (two)	Rolled steel angle (or flat)	Rolled steel channel section W H	Roll formed channel section profile W H	
1	*2*	*3*	*4*	*5*	*6*	*7*
mm	mm	mm	mm	mm	mm	mm
			H W	H W	H W	
400	6	25 x 0.8 (plain or perforated)	25 x 25 x 1.5 (or 25 x 3 flat) (plain)	25 x 25 x 1.5	20 x 25 x 1.5	3000
600	8	25 x 3 (plain)	25 x 25 x 3	25 x 25 x 3	25 x 25 x 1.5	3000
1000	8	30 x 3 (plain)	30 x 30 x 3	25 x 30 x 3	30 x 25 x 1.5	2500
1500	10	40 x 5 (plain)	40 x 40 x 3	30 x 40 x3	40 x 25 x 1.5	2500
2000	10	40 x 5 (plain)	40 x 40 x 4	30 x 40 x 4	40 x 25 x 1.5	2500
3000	12	40 x 6 (plain)	According to circumstances			

H = Height W = Width

Table 25 Supports for horizontal ducts – circular

Maximum duct diameter	Hanger		Bearer		Maximum spacing	
	Drop rod or studding (two) (dia.)	Flat strap (two)	Stirrup (Fig. 155)	Wrap-round or split clip	Spirally-wound duct	Straight-seamed duct
1	*2*	*3*	*4*	*5*	*6*	*7*
mm	mm	mm	mm	mm	mm	mm
305	–	25 x 0.8 (plain or perforated	–	25 x 0.8 (plain or perforated)	3000	1800
813	8	25 x 3 (plain)	30 x 4	25 x 3	3500	2500
1016	10	40 x 5 (plain)	40 x 5	–	3500	2500
1524	10	40 x 5 (plain)	40 x 5	–	3500	2500

Notes to Tables 24 to 26

(1) The dimensions included in Tables 24 to 26 are to be regarded as minima.

(2) The maximum spacings set out in the tables are related solely to duct weight considerations. Closer spacings may be required by reason of the limitations of the building structure or to achieve the necessary duct rigidity.

Table 26 Supports for horizontal ducts – flat oval

Maximum length of major axis	Hanger		Bearer		Maximum spacing
	Drop rod or studding (two) (dia.)	Flat strap (two)	Flat strap Fig. 154)	Rolled steel angle	
1	*2*	*3*	*4*	*5*	*6*
mm	mm	mm	mm	mm	mm
400	8	25 x 0.8 (plain or perforated)	25 x 3 (plain)	25 x 25 x 3	3000
605	8	25 x 3 (plain)	30 x 4 (plain)	25 x 25 x 3	3000
1005	10	30 x 3 (plain)	40 x 5 (plain)	30 x 30 x 3	3000
1510	10	40 x 5 (plain)	–	40 x 40 x 3	3000

Notes at foot of previous page also apply to Table 26

Fig. 137 Expansion anchor

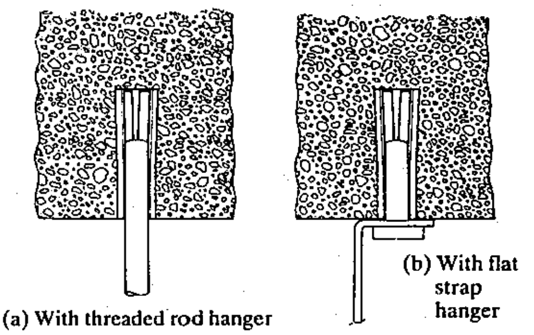


Fig. 138 Concrete insert for hanger

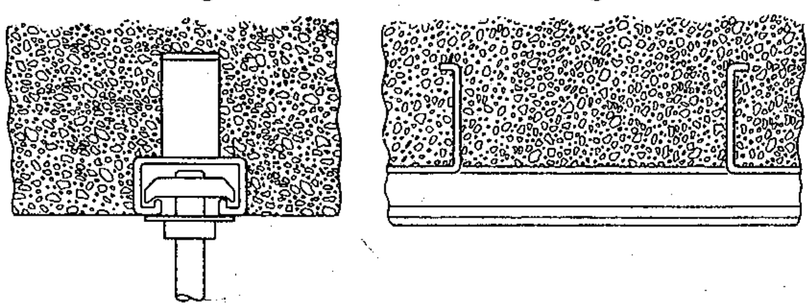
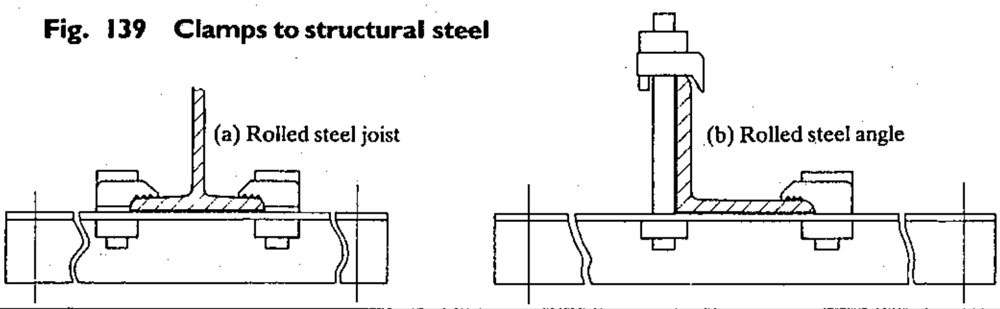


Fig. 139 Clamps to structural steel



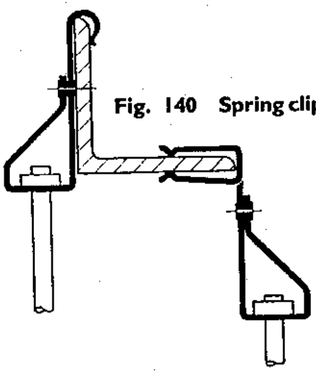


Fig. 140 Spring clips

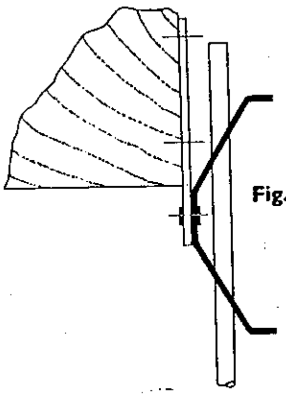


Fig. 141 Sliding spring clip

Arrangement of bearers and hangers

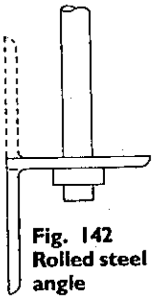


Fig. 142 Rolled steel angle

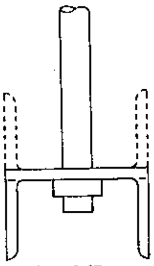


Fig. 143 Rolled steel channel

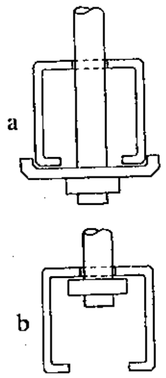


Fig. 144 Profile channel (alternatives)

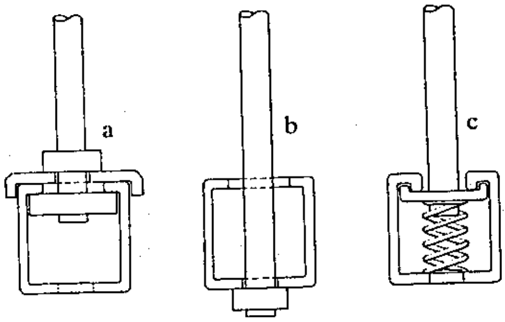


Fig. 145 Inverted profile channel (alternatives)

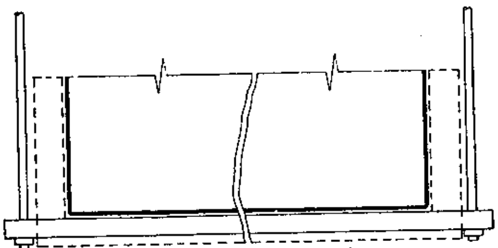


Fig. 146 Rectangular duct – plain or insulated. Can be vapour sealed to Method 1. Also applicable to flat oval ducts.

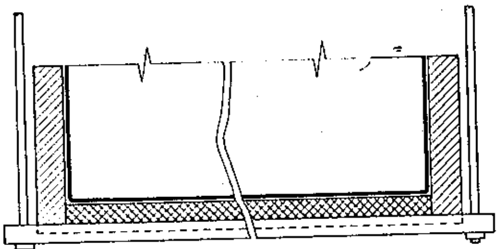


Fig. 147 Rectangular duct – insulated and vapour sealed to Method 2.

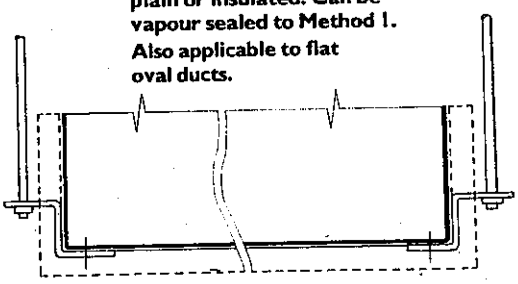


Fig. 148 Rectangular duct with corner brackets – plain or insulated. Can be vapour sealed to Method 1.

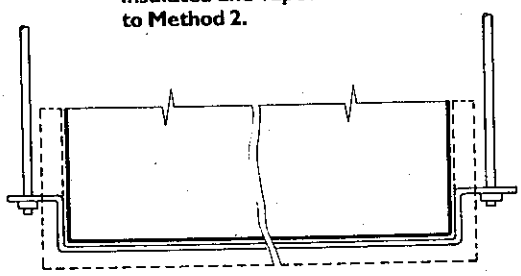


Fig. 149 Rectangular duct with stirrup bracket – plain or insulated. Can be vapour sealed to Method 1.

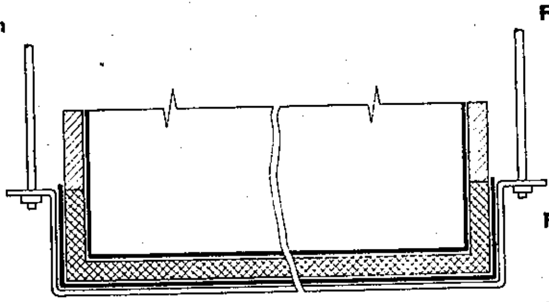


Fig. 150 Rectangular duct with stirrup bracket. Insulated and vapour sealed to Method 2.

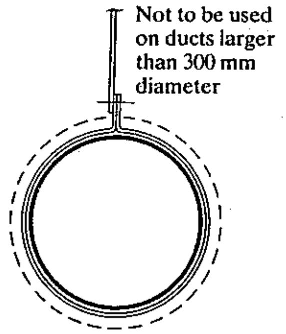


Fig. 151 Circular duct with wrap-round strip hanger – plain or insulated. Can be vapour sealed to Method 1.

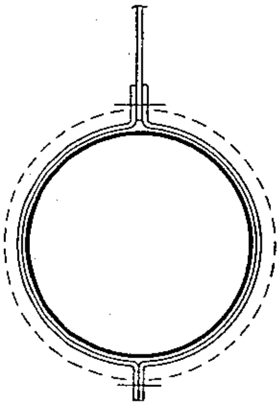


Fig. 152 Circular duct with split clip bracket – plain or insulated. Can be vapour sealed to Method 1.

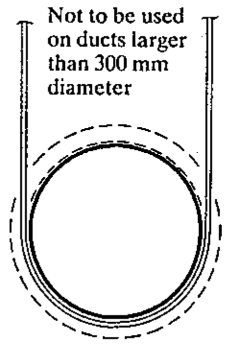
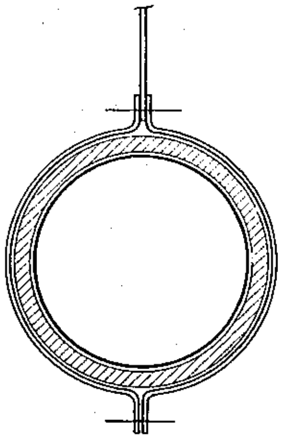


Fig. 153 Circular duct with strip double hanger – plain or insulated. Can be vapour sealed to Method 1. (Applicable also to flat oval ducts)



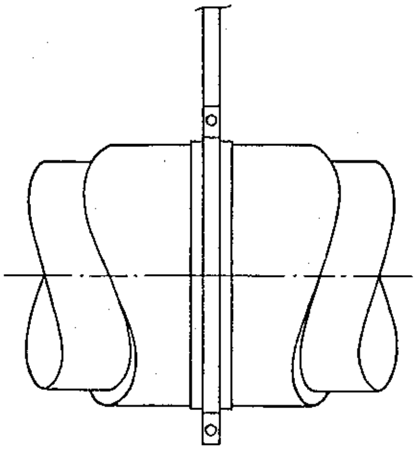


Fig. 154 Circular insulated duct with split clip bracket. Vapour sealed to Method 2.

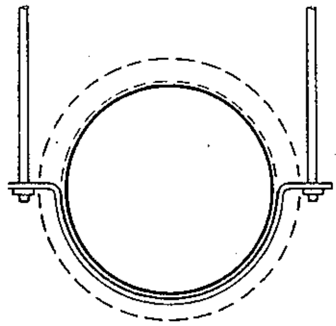


Fig. 155 Circular duct with stirrup bracket – plain or insulated. Can be vapour sealed to Method 1. (Applicable also to flat oval ducts)

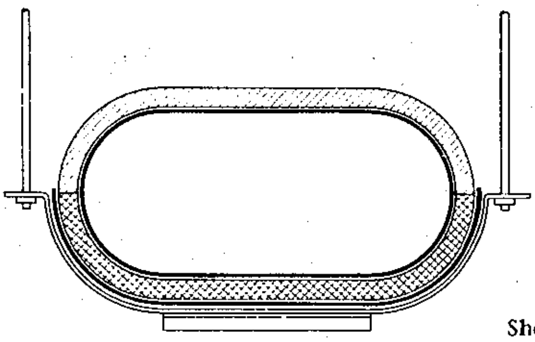
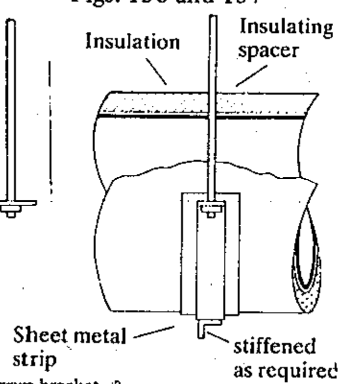


Fig. 156 Flat oval

Flat oval or circular insulated duct with stirrup bracket. Vapour sealed to Method 2. For flat oval insulated duct vapour sealed to Method 1, see fig. 146.

Applies to both Figs. 156 and 157



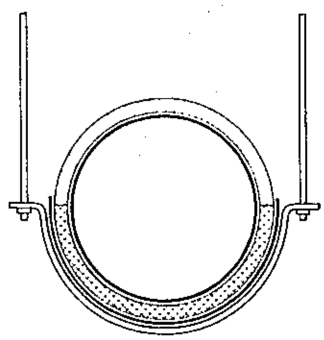
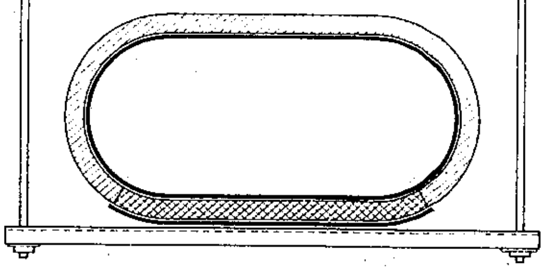


Fig. 157 Circular



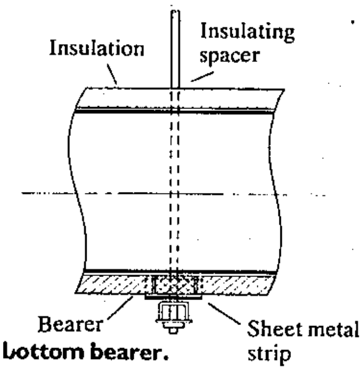
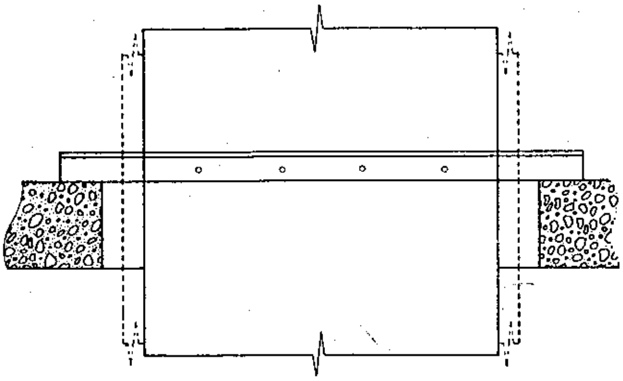


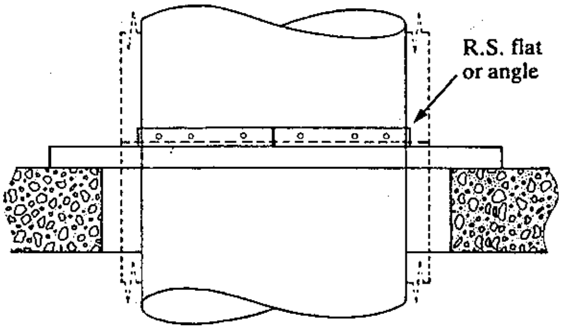
Fig. 158 Flat oval insulated duct with bottom bearer. Vapour sealed to Method 2.

Fig. 159 Vertical rectangular ducts



Plain or insulated. Can be vapour-sealed to Method 1. Vapour-sealing to Method 2 is not applicable with vertical duct supports.

Fig. 160 Vertical circular ducts



Plain or insulated. Can be vapour-sealed to Method 1. Vapour-sealing to Method 2 is not applicable with vertical duct supports.

Part Seven – General

20 ALUMINIUM DUCTWORK

20.1 Scope

This section applies only to aluminium ductwork operating at low pressure, as defined in Table 1.

In general, the requirements of this specification for low-pressure galvanized steel ductwork also apply to aluminium ductwork, subject to the special provisions set out below.

20.2 Materials

The aluminium sheet used should be chosen from those mentioned in Appendix J.

20.3 Construction – rectangular ducts

Table 27 sets out the minimum constructional and stiffening requirements for rectangular aluminium ducts and the permitted types of cross joint.

20.4 Sealant

The sealant requirements set out in this specification for galvanized steel rectangular ductwork also apply to the longitudinal seams and cross joints in aluminium ductwork.

20.5 Construction – circular ducts

Table 28 sets out the minimum constructional and stiffening requirements for circular ducts made from aluminium, and the permitted types of cross joint.

20.6 Fastenings

20.6.1 The types of fastening and the maximum spacings specified in Table 10 (rectangular) and Table 16 (circular) apply to aluminium ductwork, except that such fastenings shall be of aluminium, stainless steel or monel metal.

19.6.2 Some notes on the welding of aluminium are contained in Appendix J.

20.7 Finishes

20.7.1 No protective finishes are required for aluminium ductwork used indoors or outdoors in normal atmospheric conditions. Appendix J gives information on the use of protective finishes for aluminium where it is considered necessary for their application.

20.7.2 Mild steel section used with aluminium ductwork shall be protected as specified in Section 28 (Table 30).

Table 27 Rectangular aluminium ducts – constructional requirements

Maximum duct size (longer side)	Minimum sheet thickness	Suitable cross-joints	Maximum spacing between joints/stiffeners: Plain sheet	Maximum spacing between joints/stiffeners: With cross breaking or pleating	Minimum aluminium angle section for cross-joints and stiffeners
1	*2*	*3*	*4*	*5*	*6*
mm	mm	Figs	mm	mm	mm
400	0.8	9, 10, 33	–	–	–
600	0.8	11, 12, 33	1500	–	25 x 25 x 3
800	1.0	11, 12, 33	1200	1500	30 x 30 x 4
1000	1.0	11, 12, 33	800	1200	40 x 40 x 4
1500	1.2	11, 12, 33	600	800	40 x 40 x 4
2250	1.2	33	600	800	50 x 50 x 5
3000	1.6	33	600	600	60 x 60 x 5

Table 28 Circular aluminium ducts (spirally-wound and straight-seamed) – constructional requirements

Spiral-wound duct			Straight-seamed duct			Minimum angle section for cross joints and stiffeners	
Normal sheet thickness	Cross joints	Minimum stiffening requirements	Normal sheet thickness	Cross joints	Minimum stiffening requirements	Duct diameter	angle
						mm	mm
as for galvanised duct Table 14	figs 75 - 81 with LP Limits	as for galvanised duct Table 14	as for galvanised duct Table 15 Col. 2	figs 82 - 86 with LP limits	as for galvanised duct Table 15	510 1020 1525	25 x 25 x 3 30 x 30 x 4 50 x 50 x 5

21 ACCESS OPENINGS

21.1 General

All access openings shall be rigidly framed, with airtight covers designed so that they can be speedily removed and refixed. Multiple set screws are not recommended, and self-tapping screws are not acceptable, as a method of fixing.

21.2 Access and inspection covers

21.2.1 Subject to the restrictions imposed by duct dimensions, openings for access should not be smaller than 375 x 300 mm or larger than 450 x 375 mm; and openings for inspection should have a minimum diameter of 100 mm.

21.2.2 It shall be standard practice to provide access covers for the inspection and servicing of plant and equipment as follows.

21.2.2.1 Fire dampers
Cover to be so located as to give access both to the damper and fusible links.

21.2.2.2 Control dampers
Cover to be so located as to give access to blades and linkages on ducts with diameter or side larger than 400 mm. In branch ducts smaller than 400 mm diameter or side, inspection openings for dampers, not smaller than 100 mm by 100 mm, shall be used, with airtight cover as 21.1.

21.2.2.3 Filters
Cover to be located upstream. (*Note:* Dimensions of access openings may need to be changed to suit filter elements of the front withdrawal type.)

21.2.2.4 Cooling coils, heater batteries and humidifiers
Cover to be located upstream.

21.3 Hinged access doors

It shall be the designer's responsibility to indicate on the drawings the location of any hinged access doors required. Unless otherwise specified by the designer, openings should not be larger than 1350 mm high by 500 mm wide. Doors shall open against the air pressure. Both the opening in the duct and the access door itself should be adequately reinforced to prevent distortion. A suitable sealing gasket shall be provided, together with sufficient clamping type latches to ensure an airtight and watertight seal between the door and the duct. The latches shall have handles which can be operated from both the inside and the outside of the door.

For safety reasons, the designer should incorporate means to prevent personnel being trapped inside the duct, e.g. with operating handles both inside and outside the duct.

21.4 Test holes for plant system commissioning

It shall be standard practice to provide test holes, normally 13 mm diameter and fitted with an effective removable seal, at the following locations: at fans (in the straightest section of duct near to the fan outlet); at cooling coils and heater batteries (both before and after the coil or battery). The location of these holes shall be confirmed by the designer.

21.5 Access openings in insulated ducts

Where ducts are to be thermally insulated, it is recommended that the frame of the access door or cover be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and be so arranged that the insulation and finish can be 'dressed' into the frame, thereby ensuring that the opening is not concealed and that the edges of the insulation are protected from accidental damage. If it is necessary to insulate the access door or cover, it should be dished to contain the insulation.

21.6 Hand holes

Hand holes to permit proper joining of duct sections shall be provided at the manufacturer's discretion, but should be kept to a minimum and made as small as practicable. They shall be rendered airtight with sealant and securely fastened.

21.7 Instrument connections

Instrument connections shall be provided where shown on the contract drawings, suitably drilled or bossed and screwed to sizes given.

21.8 Openings required for other purposes

It shall be the designer's responsibility to specify the location and size of any openings required other than those covered in 21.2 and 21.4.

22 CONTROL DAMPERS

22.1 Function

Control dampers used in ductwork have three functions:

22.1.1 Isolation

To act as a shut off. Normally, the damper will be fully open, or fully closed. In the fully-open position, the damper should have minimum resistance to air flow, and when closed, maximum shut off. This type of damper is either hand- or power-actuated.

22.1.2 Balancing

To achieve the required distribution of air in the ductwork system or at inlets and outlets. For this purpose, the damper is fixed manually in any required position between fully open and fully closed.

22.1.3 Control

To secure dynamic control of the air flow in the ductwork system. In this function, the damper will always be power-actuated and may require to be continuously or intermittently operated from fully open to fully closed, and to be capable of taking up any position between these extremes. In the fully-open position, the damper should have a significant pressure drop. In the fully-closed position, it will not necessarily achieve a complete shut-off.

22.2 Types of control damper

Control dampers of various types are available for specific purposes, as follows:

22.2.1. Single-blade dampers single skin section

Plain-blade dampers (single-skin section) shall have a maximum width of 300 mm and maximum length of 300 mm for rectangular ducts; and for circular ducts a maximum diameter of 305 mm.

22.2.2 Single-blade dampers double skin section

Plain-blade dampers (double-skin section) are suitable for use in rectangular ducts, and shall have a maximum width of 300 mm and a maximum length of 1200 mm.

22.2.3 Multi-leaf dampers (single or double skin) parallel and opposed blade

There is no restriction on the size of duct in which multi-blade dampers may be used, but no individual damper blade should exceed 1200 mm in length or 175 mm in width. Where dampers are required for spans in excess of 1200 mm, the frames should be sub-divided or intermediate bearings used.

22.2.4 Iris dampers

Iris dampers are available *(for circular ducts only)* in diameters up to 460 mm. (It should be remembered that the damper *casing* is approximately twice the diameter of the duct.)

22.3 Constructional requirements

22.3.1 Low- and medium-pressure integral dampers

The following recommendations apply to dampers forming an integral part of low- and medium-pressure ductwork.

The dampers shall be constructed to prevent distortion and jamming in operation. Damper blades shall be without sharp edges. The blades shall be sufficiently rigid to eliminate movement when locked.

The blades shall be securely bolted to plated steel spindles, the ends of which shall be extended to the outside of the duct, with a groove in line with the blade. Spindles shall be carried in non-ferrous or nylon plain bearings or in ball bearings. All control dampers shall have a locking device located on the outside of the duct and shall give clear indication of the actual damper position.

22.3.2 Control dampers in high-pressure systems

Control dampers will not normally be positioned in high-pressure ducts: essential dampers should be confined to areas of relatively low pressure.

Control dampers used in high-pressure ducts shall meet the constructional requirements specified in 22.3.1, shall preferably have external linkages, and all penetrations of the duct shall be fitted with suitable seals.

22.3.3 Proprietary types of control damper

Proprietary control dampers are commonly separate units rather than integral parts of the ductwork. The use of any specific type of control damper shall be confirmed with the designer. In all cases, proprietary dampers shall meet the relevant requirements of this specification.

23 FIRE DAMPERS

23.1 General

Fire dampers are required in air distribution systems for fire and smoke containment. Generally they are called for where ducts penetrate walls or floors which form fire barriers. The damper assembly, when built in, should have a fire resistance rating equal to that of the fire barrier it penetrates.

The construction and location of fire dampers are for the designer to specify to meet the requirements of the authority directly concerned with the installation.

23.2 Types

The main types of damper are single-plate, multi-leaf and shutter. Fire dampers of these types are illustrated diagrammatically in Figs. 161 to 164.

Hinged dampers should where possible close in the direction of the air flow.

Where high *velocities* are involved, damper blades when in the open position should be clear of the air stream; therefore the arrangements shown in Figs. 161 and 163 are not recommended.

Multi-leaf dampers are not recommended for use in vertical ducts but shutter dampers may be used with the addition of an actuating spring.

23.3 Construction

In the absence of a generally agreed standard for fire dampers, the detailed construction cannot be specified. However, BS 476, Part 8, covers current requirements for fire resistance of building construction. Proprietary dampers are in general use and it will be the damper manufacturer's responsibility to meet the specification for construction and operation.

23.4 Corrosion resistance

It is recommended that fire dampers be made from an inherently corrosion-resistant material or otherwise protected to inhibit corrosion. (Some fire authorities make this a requirement).

23.5 Fusible device

Each fire damper blade assembly shall be held in the open position by a fusible device (normally specified by the fire authority to release at a temperature of 72°C), and must be designed to ensure rapid closure on release of the link.

23.6 Airtightness

Fire damper casings shall be constructed to the standards of airtightness applying to the system of which they form part.

23.7 Location

The effective formed barrier of the fire damper assembly shall be located within the structural opening. Where this is not possible the section of the casing outside the fire barrier must have a fire resistance not less than that of the fire barrier and be adequately protected against the possibility of damage by impact.

23.8 Provision for expansion

Fire damper assemblies generally include built-in clearance frames to meet the requirement that the casing be free to expand in the event of fire. The integrity of the fire barrier is maintained either by metal to metal contact or by fire resistant packing. Acceptable arrangements are shown in Figs. 165 and 166.

Fire dampers

Fig. 161 Offset hinged

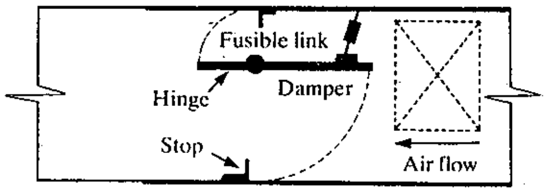


Fig. 162 Top hinged (clear of air flow)

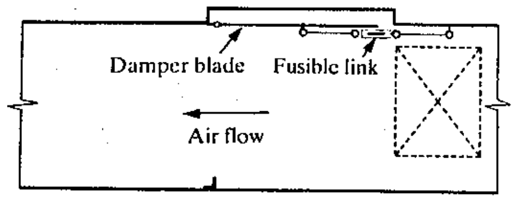


Fig. 163 Multi-leaf

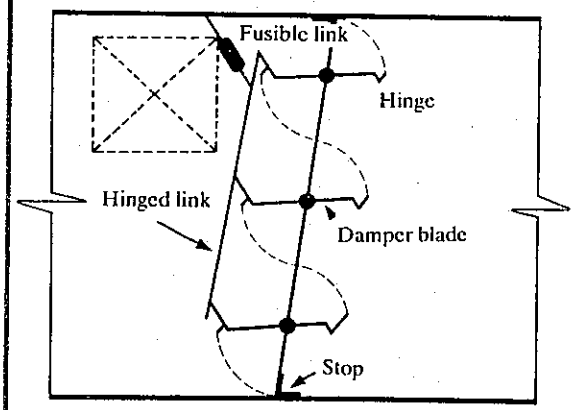


Fig. 164 Shutter

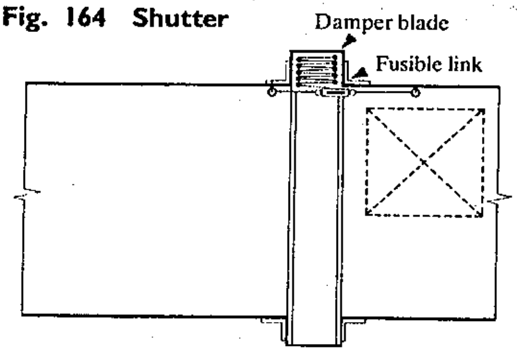


Fig. 165 Standard approved method of framing applicable to Fig. 164

This design was developed in collaboration by HVCA and the HEVAC Association and is approved by the Greater London Council

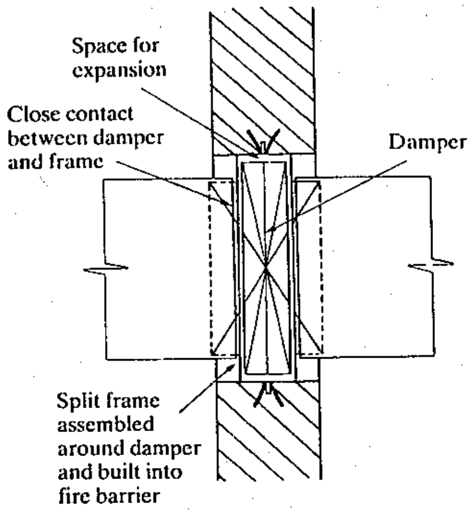
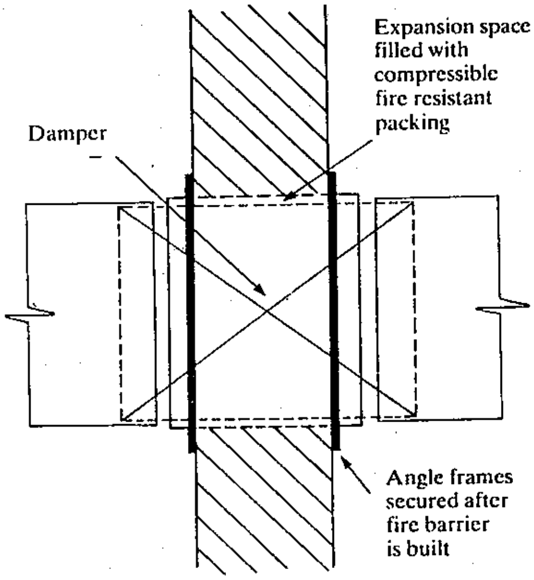


Fig. 166 Framing applicable to Figs. 161, 162 and 163

This method is also normally used for a multiple assembly of shutter-type fire dampers



24 BENDABLE AND FLEXIBLE DUCTS – METAL

There are two types of these ducts: (a) metal (including plastics-coated metal), which can be bent but not repeatedly flexed; and (b) ducts in metal, which can be flexed a limited number of times without failure.

Ducts of these types may require special consideration in relation to fire hazards, and it is therefore advisable that the requirements of the relevant fire authority are met before installation.

24.1 Types available

24.1.1 Bendable ducts – metal

A number of bendable ducts are available, helically-wound with lock seam to form a corrugated duct capable of being bent or set by hand without spring back and without deforming the circular section. The metals used are aluminium, stainless steel, tin-coated steel or aluminium-coated steel. Plastics-coated bendable ducts are also available.

24.1.2 Flexible ducts – metal

Some proprietary ducts of this type, in various metals, are available, having single or multiple layers of strip formed into corrugations and wound in helical or annular form, without any obvious seam or joint.

24.2 Performance

Bendable and flexible ductwork must meet the standards of airtightness required by the specification and be within the frictional limits specified by the designer.

24.3 Manipulation

24.3.1 General

Bendable or flexible ducts made of aluminium (particularly in the larger diameters) can be bent and manipulated more readily than those made of steel, but are more easily distorted and more susceptible to damage.

Because of the spiral corrugation and lock seam, care is necessary when cutting.

24.3.2 Bendable ducts – metal

Bends are made by closing the corrugations in the throat and slightly opening the corrugations at the back of the bend. Some readjustment is possible with large radius bends, but small radius bends cannot be straightened without leaving some distortion of the corrugations. Repeated bending should be avoided. Care must be taken to maintain the integrity of the lock seam.

Elongation and compression are limited, and this must be taken into account with short connections between fixed points.

24.3.3 Flexible ducts – metal

These ducts will withstand several bendings through 180° and will accept sufficient linear compression and re-expansion to facilitate installation between oppositely located spigots.

24.4 Jointing

Joints can be made with sealant or by enclosure using heat-shrinkable band or strip or by chemical reaction tape.

When sealant is used, it should form a continuous barrier, and this can be achieved by a build-up of sealant against the swage on the spigot or by an equivalent stop.

Whichever method of jointing is chosen, it should ensure that the air passage resulting from the spiral corrugation is sealed.

Fastenings should be as for rigid circular ducts (Table 16).

24.5 Supports
The light weight of the duct, plain or pre-insulated, makes heavy and closely-spaced supports unnecessary. If in doubt, the manufacturer's recommendations should be followed.

24.6 Insulation
It is practicable to insulate metal bendable ducts before erection. Several manufacturers offer their ducts pre-insulated with soft lagging. More complicated cutting, bending and jointing techniques are involved.

24.7 Acoustic treatment
Pre-insulated ducts are also available in specified lengths with perforations in the metal to provide sound absorption. Special care is necessary during installation to ensure that the outer casing is made airtight.

24.8 Test holes
It is not practicable to make test holes in flexible/bendable ducts where readings are required; the test holes should be made in the rigid ductwork.

25 FLEXIBLE DUCTS – FABRIC

25.1 Function
The principal use of non-metallic duct is to join rigid ductwork to terminals in cases where a flexible duct is needed to make a short connection between fixed points.

As these types of duct may constitute a fire hazard, it is essential that the requirements of the relevant fire authority are met in all cases.

25.2 Construction
Suitable constructions available comprise: (a) a tough, tear-resistant fabric liner and cover, proofed with synthetic rubber, enclosing a galvanized spring wire helix and reinforced with an outer helix of glass-fibre cord. This type of duct is also available without a liner.

(b) A tough, flexible aluminium laminate, supported by a reinforcing helix of aluminium alloy or steel.

Other constructions for flexible ducts are available, but in all cases they should comply with the requirements of 25.3.

25.3 Performance
Flexible ductwork must meet the standards of airtightness required by the specification and be within the frictional limits specified by the designer.

25.4 Length
The length of flexible duct used in each case should be kept to a minimum, consistent with the particular application.

25.5 Joints
These will normally be socket and spigot, with sealant, as for rigid ductwork, and the joint secured by a worm drive or bolted clipband. In some cases soft cuffs are bonded to the flexible ducts. The manufacturer's recommendations as to jointing and sealant should be followed.

25.6 Supports
Flexible ducts should be supported in such a way that kinking of the duct is avoided.

25.7 Test holes
It is not practicable to make test holes in flexible fabric ducts. Where readings are required, the test holes should be made in the rigid ductwork.

26 FLEXIBLE JOINTS

26.1 General properties
The material (normally a treated canvas) used for flexible joints must meet any conditions of temperature, air pressure and fire resistance specified, and shall comply with the standard of airtightness specified for the rest of the ductwork system of which it forms part.

26.2 Location
Flexible joints should normally be fitted at inlet and outlet connections to all fans. Any others required should be indicated on the design drawings. Care should be taken to maintain alignment between the fan and the duct connection.

26.3 Length
Flexible joints shall be kept as short as practicable above a minimum effective length of 50 mm. In no case shall a flexible joint exceed 250 mm in length.

26.4 Connections to rectangular ducts
With flanged rectangular connections, the flexible material shall be held in place with flat bar strips attached to a mating flange (Fig. 167). For spigot connections, the flexible material shall be held in place with flat bar strips (Fig. 168). Flat bar strips shall be used with proprietary flexible material having sheet metal attached along the edges. Flat bar strips shall be not less than 3 mm thick.

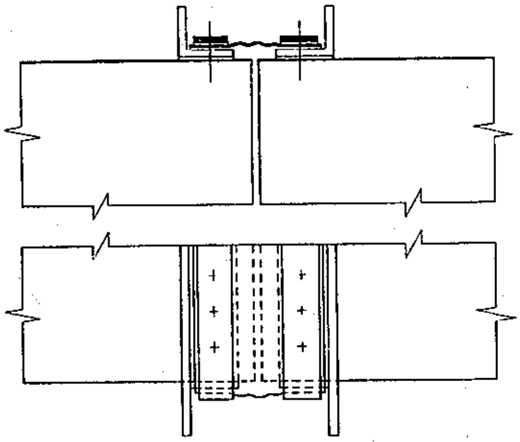


Fig. 167 Flexible joints – flanged connection

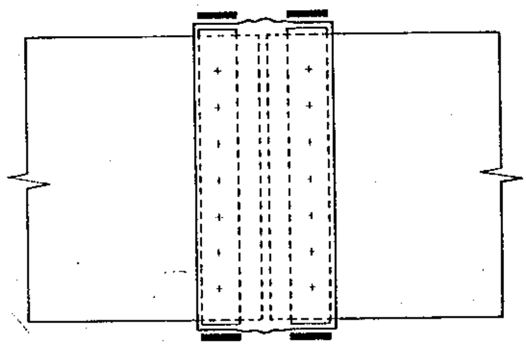


Fig. 168 Flexible joints – spigot connection

26.5 Connection to circular and flat oval ducts

Adaptors shall be used to provide plain circular ends for spirally-wound ducts. Alternatively, flanged connections may be used, adapting the method set out in 26.4. A sealant in accordance with the requirements of Section 27 shall be used between the duct and the flexible joint, and the joint secured by clip-bands with adjustable screw or toggle fittings.

27 SEALANTS, GASKETS AND TAPES

For the purpose of this specification, sealing materials and methods are classified as set out below.

27.1 General properties

Sealants and the other materials covered by this section, when used in connection with ductwork, shall permanently retain adhesion and elasticity through a temperature range of 0° to 70°C.

27.2 Liquid and mastic sealants

Any form of sealing substance applied by brush, trowel or injection gun to a joint formed between two sheets of metal or between sheet and an adjoining member.

27.3 Gaskets

Sealant in the form of a pre-formed roll, sheet or strip applied between opposing faces of flanged or other joints. Gaskets should be not less than 3 mm thick for rectangular ducts up to 1500 mm longer side or circular ducts up to 1250 mm diameter; for larger ducts, the gasket should be not less than 4 mm thick.

27.4 Chemical reaction tape

A wrapping which sets through the interaction of the activator material and the chemical substances in the tape, thereby sealing the joint.

27.5 Heat-shrinkable band and strip

A thermoplastic material, supplied as a continuous band or in strip form, coated on the inside with an adhesive. When heated, the material shrinks to a tight fit over the joint. The shrinkage is maintained until the material is reheated.

27.6 Self-adhesive tape

PVC or other plastic self-adhesive tape, with or without fabric or other reinforcement.

27.7 Methods of use

The manufacturer's recommendations and precautions relating to use must be strictly complied with.

Any form of sealant under compression is more likely to be successful than a sealing method (such as tape) applied over a joint. Therefore, a sealant should, if possible, be applied so as to ensure that the air pressure within the duct system will cause it to be set into a possible source of leakage rather than be blown out of it.

27.7.1 Drying and/or curing period

Solvent based and chemical reaction types of sealant require a period of between 24 and 72 hours for drying or curing, depending on conditions. The cure should be completed before the duct is pressurised; otherwise rupture of the joint is possible.

27.7.2 Self-adhesive tape

The use of self-adhesive tape as a primary sealant is deprecated. It is in practice extremely difficult to achieve the dry, dust-free and grease-free surface necessary for the long-term adhesion of such tapes. There is the further disadvantage that where the air pressure in the ducts is above ambient, the air pressure is working against the seal.

28 PROTECTIVE FINISHES

For all normal purposes, protective finishes shall be as specified by the designer in accordance with the following.

28.1 Galvanizing after manufacture
Galvanizing after manufacture is not recommended for general use, as distortion of the duct or fitting is probable, thus making if difficult to achieve an airtight joint. Galvanizing after manufacture is, however, an acceptable protective finish for circular pressed fittings.

Where galvanizing after manufacture is specified, it shall be to BS 729.

28.2 Metal spraying
Zinc or aluminium spraying shall be to BS 2569, Part 1.

28.3 Paints

28.3.1 Surface preparation and paint application
Surface preparation of the metal and paint application shall be in accordance with the paint manufacturer's recommendations.

28.3.2 Making good welding damage
Galvanizing or other metallic zinc finish damaged by welding shall be suitably cleaned and painted with one coat of zinc-rich or aluminium paint.

28.3.3 Ducts galvanized after manufacture
No paint protection is required for ducts galvanized after manufacture, whether such ducts are installed inside or outside a building.

28.3.4 Ducts made from galvanized sheet or coil
Ducts made from conventional sheet or coil (see 7.2.1) do not require further protection when located inside a building. When located outside a building, one coat of etch primer or one coat of calcium plumbate primer shall be applied, together with a suitable finishing coat. (But see 28.3.6.)

28.3.5 Ducts made from other types of mild steel sheet
Where circumstances require ducts to be made from mild steel sheet or coil other than the foregoing, the surfaces shall be adequately protected, as provided in Table 29.

The provisions set out in the table are generally in line with BSI DD.24 – Methods of protection against corrosion on light steel section used in building.

28.3.6 Supporting members
Supporting members made of mild steel shall be protected as provided in Table 30.

28.3.7 Follow-on coats
The supply and application of the follow-on coats specified in Tables 29 and 30 together with any additional decorative finishes, are not normally the responsibility of the ductwork contractor.

As priming coats protect only for a limited period, the follow-on coat or coats should be applied within the time limit specified by the paint manufacturer.

Table 29 Protective finishes for ductwork other than covered by 28.3.4

Ducts constructed from	Exposure	Paint system: Primer	Paint system: Follow-on coats
1	*2*	*3*	*4*
Steel sheet—iron-zinc alloy coated	Indoors	None	None
	Outdoors	Zinc chromate, calcium plumbate *or* red oxide	Two
Steel sheet—zinc electro-plated	Indoors	Etch primer, zinc chromate *or* calcium plumbate	One
	Outdoors	Etch primer, zinc chromate *or* calcium plumbate	Two
Black sheet—sprayed zinc or sprayed aluminium	Indoors	Etch primer, zinc chromate, calcium plumbate *or* red oxide	One
	Outdoors	Etch primer, zinc chromate, calcium plumbate *or* red oxide	Two
Black sheet—other than metal sprayed	Indoors	Zinc rich, zinc chromate *or* red oxide	One
	Outdoors	Zinc rich *or* zinc chromate	Two

Table 30 Protective finishes – supporting members, etc.

Supporting members and other section	Exposure	Paint system	
		Primer	Follow-on coats
1	*2*	*3*	*4*
Steel—galvanized or metal sprayed	Indoors	None	None
	Outdoors	Etch primer *or* calcium plumbate	Two
Steel—not galvanized or metal sprayed	Indoors	Zinc rich, zinc chromate *or* red oxide	One
	Outdoors		Two

29 CONNECTIONS TO BUILDER'S WORK

29.1 Where metal ducts and fan inlets and outlets connect to builder's work, connections shall be by built-in timber frame of suitable section or built-in companion ring or flange. **Where metal ducts pierce fire barriers, timber frames shall never be used.** Companion rings or flanges shall be fixed by an adequate number of suitably sized rag bolts or similar fastenings.

29.2 In all cases the duct end must be finished with a mating flange where fixed to a timber frame. Where there is no timber frame, the duct shall be extended, in the form of a spigot, beyond the flanged connection and into the builder's work.

29.3 Joints between mating flanges and companion rings or wooden frames shall be fitted with a sealing gasket *(see Section 27)*.

29.4 Where ducts are connected to outside louvres, the bottom of the duct should be sloped to drain to outside. The inside surfaces of the duct shall be treated as Table 29 for external exposure for a distance equal to the height of the louvre connection, or to the nearest plant item.

30 ACOUSTIC LININGS

30.1 Where a lining to ductwork is required, it should preferably be fitted at works. Before manufacture, confirmation should be obtained that the dimensions of the duct allow for the thickness of the lining.

30.2 The type of lining, normally glass fibre or mineral wool slab and faced to minimise fragmentation and 'fibre-fly', should be approved by the designer for type and thickness. Regard should in appropriate cases be had to the fire characteristics of the material.

30.3 Duct surfaces must be thoroughly clean and the lining fixed by an approved type of adhesive applied over the whole of the area to be lined. In addition, fasteners must be used at 450 mm maximum centres, and not more than 75 mm from joints, corner breaks, etc., with washers or caps to hold the lining. In some circumstances metal mesh may be called for by the designer as an additional precaution against displacement or break-up of the lining.

30.4 The lining must be applied so as to provide abutment at joints and edges, with continuity of facing material. For protection prior to erection, the edges of the lining should be sealed or enclosed by a light metal section mechanically fastened to the duct.

31 THERMAL INSULATION

31.1 The provision and application of thermal insulation to ductwork is not normally the responsibility of the ductwork contractor. It should be borne in mind that the application of rigid slab insulation is more difficult if the duct panels have been stiffened by cross-breaking or beading.

31.2 Where ductwork is required to be pre-insulated, the specification should be agreed with the designer.

31.3 For detailed information on the thermal insulation of ductwork, reference should be made to BS 5422: 1977 – Specification for the use of thermal insulating materials; and BS 5970: 1981 – Code of practice for thermal insulation of pipework.

Part Eight – Appendices

APPENDIX A – AIR LEAKAGE FROM DUCTWORK

A.1 GENERAL CONSIDERATIONS

A.1.1 Leakage points in ductwork
Air leakage in installed ductwork occurs almost entirely at the longitudinal seams and the cross joints, particularly at the corners, and at the intersection of the seams and cross joints.

A.1.2 Leakage related to duct area
In practice, leakage can be taken as proportional to the surface area of the ductwork, whether rectangular or circular, even though there may be considerable variation in different sections of a complete system because of the changing sizes of the ducts and the number and variety of the fittings. The surface area is easily calculable as part of the design procedure.

A.1.3 Pressure/leakage relationship
For a given pressure, the leakage through an orifice of a given area will vary according to its shape. With installed ductwork, the leakage orifices are of differing shapes, so a precise value cannot be given to the pressure/leakage relationship. However, Swedish tests on a variety of constructions have shown that for ductwork operating within the range covered in this specification, leakage can be taken as proportional to pressure to the power of 0.65. (This value has been adopted by EUROVENT in preparing their Document 2/2 – Air Leakage in Ductwork – see Appendix L – and has also been adopted in this specification (see Table 2) and has been applied in Table 31.

A.2 LEAKAGE LIMITS – RELATIONSHIPS

A.2.1 Limits for each pressure class
Applying the values given in Table 2 (page 13), the permitted leakage at each of a series of pressures up to the maximum for each class is set out in Table 31.

A.2.2 Graphical presentation
The pressure/leakage relationships given in Table 31 are expressed graphically in Fig. 169.

A.2.3 Leakage as a percentage of airflow
As air leakage is related to surface area of the ductwork, it cannot in advance of the detailed calculations be expressed as a percentage of total airflow, nor will a percentage loss be acceptable as a standard of performance. However, application of the leakage limits to a variety of ductwork systems indicates that **under operating conditions** air losses will usually be within 6 per cent of total airflow for the low-pressure class and 3 per cent for the medium-pressure class. For the high-pressure class, air loss is likely to be between 2 and 0.5 per cent, according to which leakage limit is applied.

A.2.4 Special cases
The percentages mentioned in A.2.3 apply to normal ratios of duct area to airflow; but where the ratio is high (e.g., long runs of small ducts), it may be necessary for the designer to specify a higher standard of airtightness in order to keep the actual leakage within an acceptable limit.

A.2.5 Designer's required calculations
Designers will be concerned with the total loss of air through leakage which must be allowed for the ductwork, and will need to:

(a) calculate the pressure class;
(b) calculate the surface area and estimate the mean system pressure difference for the ductwork system (or part of system);
(c) calculate the total leakage using the appropriate rate from Table 31.

Alternatively, the designer may:

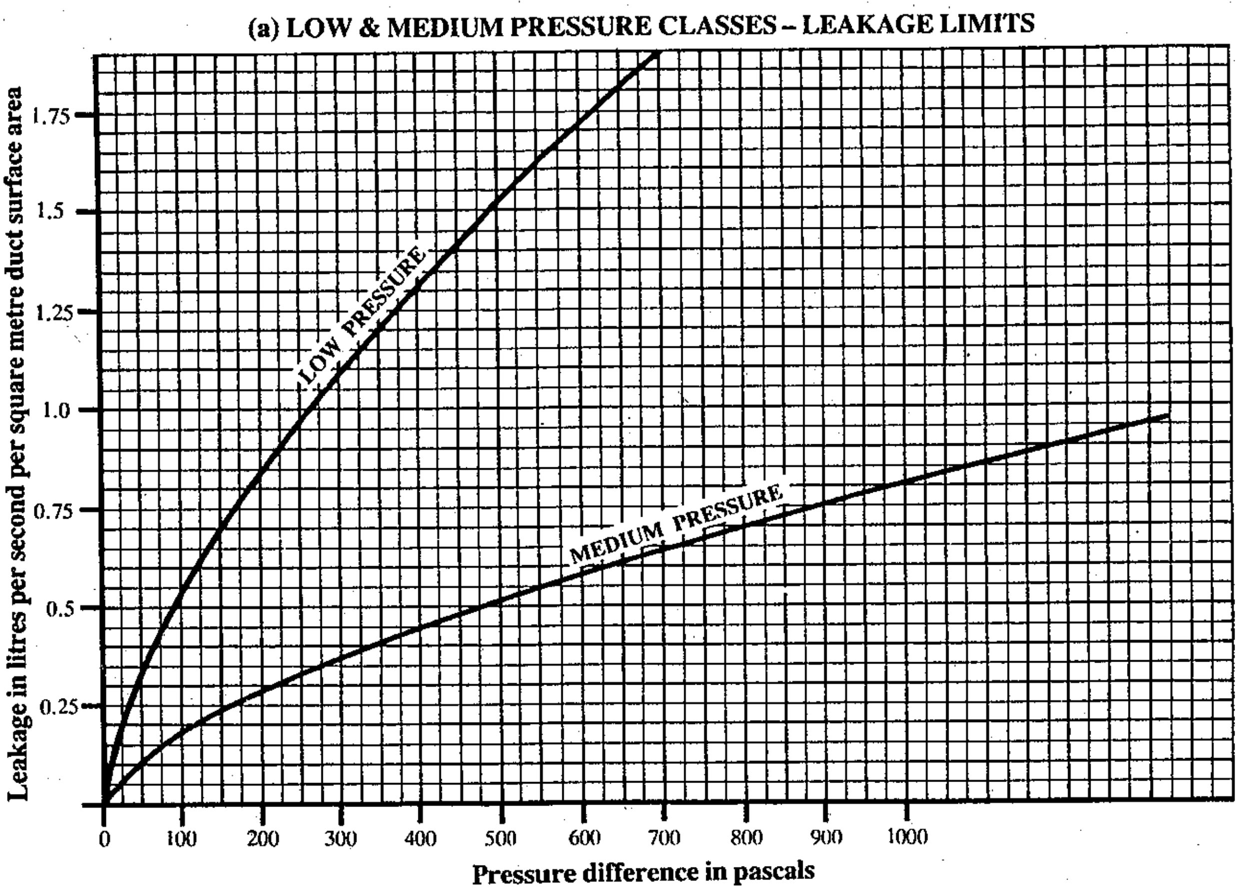
(d) decide on the maximum total leakage that he can accept;
(e) calculate the surface area and estimate the mean system pressure difference for the ductwork system (or part of system) and from these determine the required pressure class.

A.2.6 Leakage of complete system
DW/142 deals only with the ductwork. The leakage characteristics of plant items and accessories are not within the control of the ductwork contractor, and therefore any leakage limits and leakage testing called for under DW/142 shall be understood to apply only to the ductwork itself.

Table 31 Air leakage rates

Static pressure differential	Maximum leakage of ductwork			
	Low-pressure Class A	Medium-pressure Class B	High-pressure Class C	High-pressure Class D
1	*2*	*3*	*4*	*5*
Pa	Litres per second per square metre of surface area			
100	0.54	0.18		
200	0.84	0.28		
300	1.10	0.37		
400	1.32	0.44		
500	1.53	0.51		
600		0.58	0.19	
700		0.64	0.21	
800		0.69	0.23	
900		0.75	0.25	
1000		0.80	0.27	
1100			0.29	0.10
1200			0.30	0.10
1300			0.32	0.11
1400			0.33	0.11
1500			0.35	0.12
1600			0.36	0.12
1700			0.38	0.13
1800			0.39	0.13
1900			0.40	0.14
2000			0.42	0.14
2100				0.14
2200				0.15
2300				0.15
2400				0.16
2500				0.16

Fig. 169 Permitted leakage at various pressures



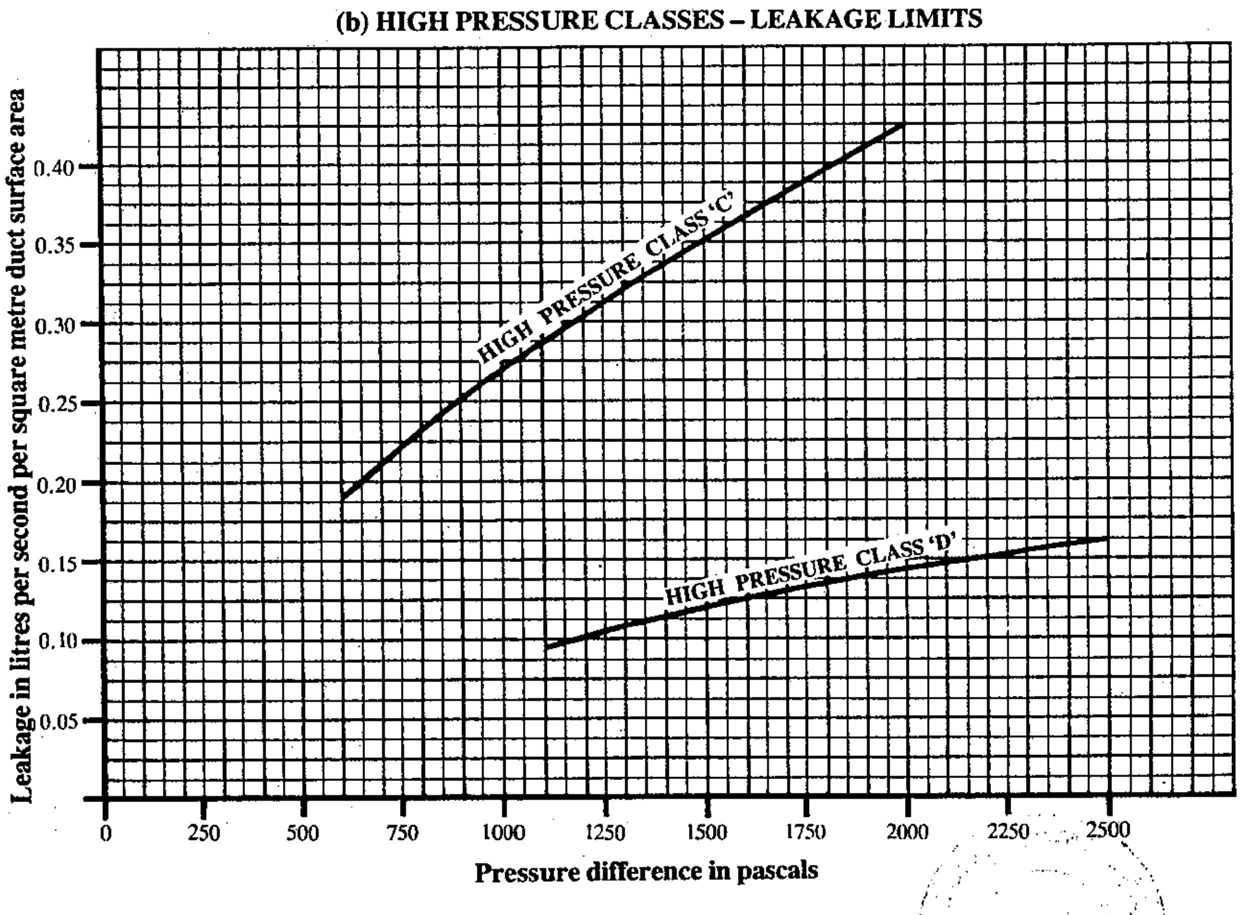
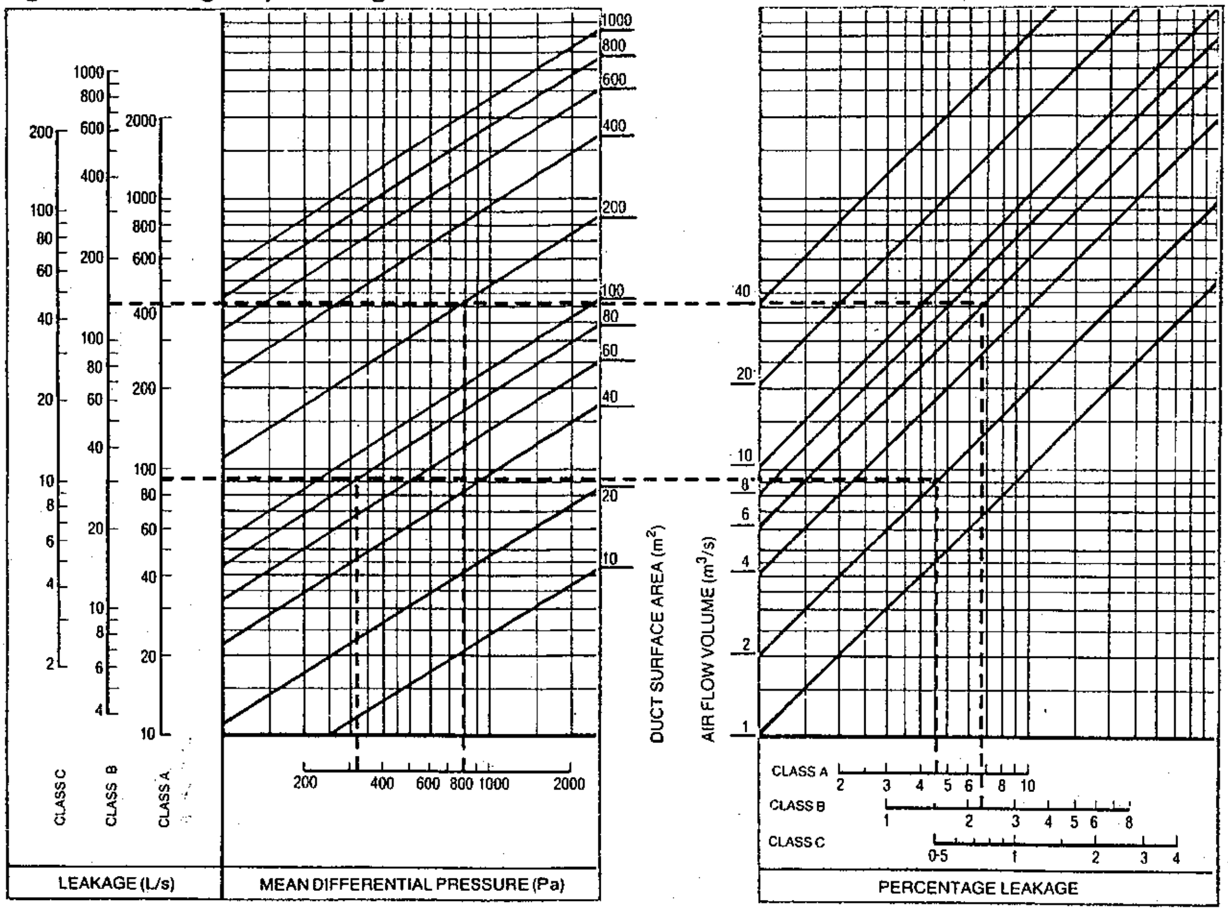


Fig. 170 Leakage as percentage of airflow



Examples of use of charts

	Example 1 Class A	Example 2 Class B
Mean differential pressure	320 Pa	800 Pa
Duct area	80 m²	200 m²
Airflow	2 m³/s	6 m³/s

	Calculated	Chart reading	Calculated	Chart reading
Maximum permitted leakage	91.8	92	138.8	139
Percentage of airflow	4.58	4.6	2.31	2.3

Based on charts prepared by EUROVENT, reproduced by kind permission.

APPENDIX B – AIR LEAKAGE TESTING PROCEDURE

B.1 GENERAL

Section 6 (page 13) of this specification deals with the performance requirements of ductwork in respect of air leakage, and Table 31 (Appendix A) tabulates the limits of leakage applicable to each class of ductwork. Appendix B is solely concerned with recommendations for the testing procedure.

B.2 Extent of ductwork to be tested

B.2.1 The procedure set out in this section is limited to the ductwork. Terminal connections, and items such as air handling devices, terminal boxes, sound attenuators, heat exchangers, builder's work construction, are excluded from the tests.

B.2.2 The proportion of the ductwork to be tested and the method of selection (where not included in the job specification) should be determined in collaboration between the designer and the ductwork contractor. Where the method is by random selection, the use of polythene sheet or similar insertion blanks between duct cross joints and duct-mounted components will assist in avoiding delays in installation when tests are being carried out.

B.2.3 To enable the blank to be cut out after the testing is completed, access may be required adjacent to each blank. This procedure used on either side of a duct-mounted component will enable the component to be included in a subsequent additional test if specified.

B.2.4 Alternatively, rigid removable blanking plates can be used, although this involves remaking joints.

B.3 Testing to be completed before insulation, etc.

Testing shall be satisfactorily completed before insulation or enclosure of the ductwork and before terminal units (if any) are fitted.

B.4 Retesting procedure where necessary

B.4.1 The air leakage rate for any section shall not be in excess of the permitted rate for that section. If a first test produces leakage in excess of the permitted maximum, the section shall be resealed and retested until a leakage not greater than the permitted maximum for that section is achieved.

B.4.2 If at the time of witnessing the test it is apparent that excessive additional sealing of seams or joints has been done in order to meet the required leakage level, the section of ductwork under test shall not be counted as part of the tested ductwork, except where the whole of the ductwork is required to be tested.

B.5 Minimum area to be tested

The section of ductwork to be tested shall have an area large enough to enable the test apparatus to register a measurable leakage.

B.6 Test pressures and leakage rates

The maximum permissible leakage rates for the full range of pressures are given in Table 31. The recommended test pressures for the various classes of ductwork are set out in Table 32, and unless otherwise specified, the choice of test pressure shall be at the discretion of the test operator.

Table 32 Recommended maximum test pressures (with leakage rates)

Static pressure differential	Maximum leakage of ductwork			
	Low-pressure Class A	Medium-pressure Class B	High-pressure	
			Class C	Class D
1	2	3	4	5
Pa	Litres per second per square metre of surface area			
200	0.84			
400	1.32	0.44		
800		0.69		
1200			0.30	
1500			0.35	0.12
2000				0.14

B.7 Test apparatus

B.7.1 The accuracy of the test apparatus shall be within:

± 10 per cent of the indicated flow rate, or 0.4 litres per second, whichever is the greater; and

± 5 per cent at the indicated static pressure in the duct under test.

B.7.2 The test apparatus shall be inspected by the user before use on site, and shall have a calibration certificate, chart or graph dated not earlier than one year before the test for which it is used.

B.7.3 A diagram of a suitable test apparatus is given in Fig. 171.

B.8 Procedure

B.8.1 The section of ductwork to be tested for air leakage shall be sealed. Main ducts should be provided with flanged joints to enable blanking plates to be fitted, while small open ends may be sealed with polythene or inflatable bags, which should be left in position until final connections are made.

B.8.2 On low-pressure systems, final grille spigots made as a second fix operation shall be excluded from the test. The joint shall, where practicable, be checked by external visual examination.

B.8.3 Sufficient time shall be allowed between erection and leakage testing for sealants to cure.

B.8.4 Special care must be exercised in making all joints which fall outside the scope of the testing procedure, i.e., joints between tested sections of ductwork and between ductwork and other units.

B.8.5 Due notice of tests shall be given, so that arrangements for witnessing the tests, if required, can be made.

B.9 Testing sequence

The recommended sequence of testing is as follows.

B.9.1 Complete Part 1 of the Test Sheet.

B.9.2 Connect test apparatus to section of ductwork to be tested.

B.9.3 Adjust test apparatus until the static pressure differential is obtained.

B.9.4 Check that the measured leakage is within the permitted rate. (No addition shall be made to the permissible leakage rate for access doors, access panels or dampers where these are included in the ductwork.)

B.9.5 Maintain the test for fifteen minutes and check that the leakage rate has not increased.

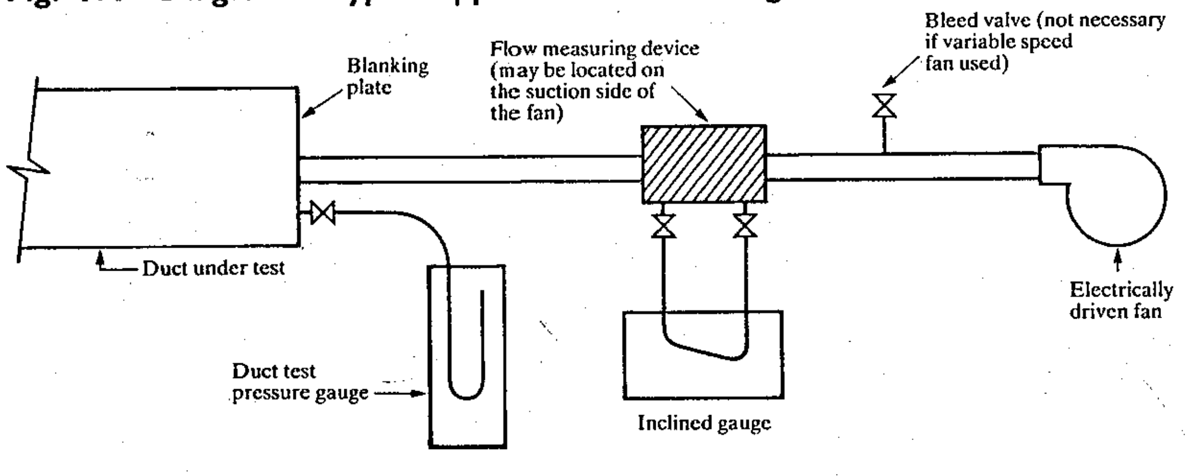
B.9.6 Reduce pressure in section to zero by switching off the fan; then immediately re-apply test pressure to establish that the air leakage rate is not greater than the previous reading.

B.9.7 Record details on Part 2 of the Test Sheet and complete, including witnessing.

B.10 Air leakage test sheet

A specimen of a suitable Test Sheet is given on page

Fig. 171 Diagram of typical apparatus for air leakage tests



Attention is drawn to HVCA publication DW/143 – A Practical Guide to Ductwork Leakage Testing – which gives detailed advice on the actual procedure for ductwork leakage testing.

Specimen of air leakage test sheet

*Test No. ....

General

Name of job ....

Building reference ....

Part 1 – Physical details

a Section of ductwork to be tested* ....

b Surface area of duct under test† ....

c Test static pressure ....

d Leakage factor ....

e Maximum permitted leakage (b x d) .... litres/sec.

Part 2 – Test particulars

a Duct static pressure reading ....

b Type of flow measuring device ....

c Range of measurement of flow measuring device ....

d Reading of flow measuring device ....

e Interpreted air flow leakage rate ....

f Duration of test (normally 15 minutes) ....

Date of test .... Carried out by .... Witnessed by ....

Length	Width and depth or diameter	Periphery	Area
metres	millimetres	millimetres	square metres
		†TOTAL	

APPENDIX C – IDENTIFICATION OF DUCTWORK

Note
The information given in this Appendix is for the guidance of mechanical service contractors, consulting engineers, etc. The identification of ductwork does not form part of the work carried out by the ductwork contractor unless called for in the job specification.

C.1 GENERAL

C.1.1 Introduction

With the increasing complexity of ventilation and air conditioning systems, it is becoming more important to ensure ready identification of ducts for the purposes of commissioning, operation and maintenance of systems. The purpose of these recommendations is to lead towards the use and standardisation of a system of identification for ducts for the benefit of designers, contractors and clients.

C.1.2 Scope

C.1.2.1 These recommendations deal with the identification of ducts for ventilation, air conditioning and simple industrial exhaust systems. They do not include piped gas systems such as are dealt with in BS 1710, nor with ductwork systems for industrial processes, although the general considerations and intentions could be extended with the agreement of the client to cover such systems.

C.1.1.1 The method is designed to identify the air being conveyed, the direction of flow, the destination of the air and/or of the plant where the air was treated. With small or simple plants, it may not be strictly necessary to provide identification because the function is apparent, but it is considered advisable to do so because this will increase familiarity with the labelling system and also because the nature and direction of air flow may not always be apparent.

C.2 IDENTIFICATION

C.2.1 Location

To be effective the identification must be placed where it can be easily seen and at positions where identification will be required. To ensure that the symbols are seen, the following points should be considered.

C.2.1.1 The symbols should be on the surfaces which face the positions of normal access to the completed installation.

C.2.1.2 The symbols should not be hidden from view by structural members, other ducts, plant, or other services distribution systems.

C.2.1.3 The symbols should be placed where there is adequate natural or artificial light.

C.2.2 Identification symbols will be needed mainly in the plant room. Symbols should occur frequently enough to avoid the need for ducts to be traced back. Symbols should be placed at any service and access points to the distribution system, including points where the distribution system has reduced to a single duct.

C.2.3 Colour coding

The choice of colours has been based on the need to provide:

C.2.3.1 Strong contrasting colours which are recognisable even though covered with dust.

C.2.3.2 Contrast between the symbol colour and the base colour of the duct. Usually the base colour metallic grey of galvanized or aluminium sheet or foil sheathing, or the white, pale grey, or buff paint on the insulation is a neutral colour against which the recommended symbol colours will stand out.

C.2.4 The recommended colours are given in Table 33. The colour coding indicates the type of air being conveyed.

Table 33 Recommended duct identification colours

Type	Colour	BS 4800
1	*2*	*3*
Conditioned air	Red and Blue	04 E 53 18 E 53
Warm air	Yellow	10 E 53
Fresh air	Green	14 E 53
Exhaust/extract/ recirculated air	Grey	AA O 09
Foul air	Brown	06 C 39
Dual duct system— hot supply air	Red	04 E 53
Dual duct system— cold supply air	Blue	18 E 53

C.2.5 For conditioned air, two symbols (one red, one blue) may be used, or a single symbol coloured part red, part blue.

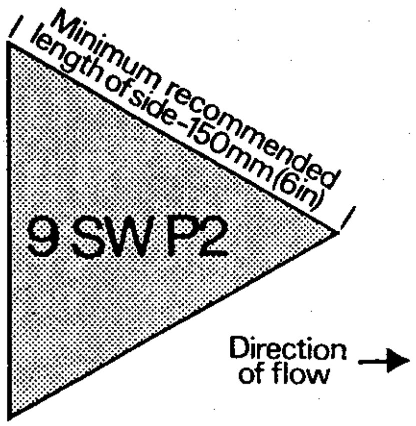
C.2.6 If a finer grading than that given in Table 33 is required, as for instance in a laboratory with two separate contaminated air exhaust systems, it is recommended that the type colour be used with, say, a stripe of a second colour. Where the duct contents constitute a hazard, a symbol as given in BS 1710 should be added to the type colour.

C.2.7 Direction of flow

C.2.7.1 The form of symbol chosen indicates direction. It is an equilateral triangle (see Fig. 172) with one apex pointing in the direction of air flow. Where the boundaries of the duct are not visible, two triangles should be arranged in line ahead to indicate direction of flow.

C.2.7.2 The size of the symbol will depend on the size of the duct and the viewing distance. The recommended minimum size for normal use is 150 mm length of side.

Fig. 172 Example of duct identification symbol



C.2.8 Further identification

C.2.8.1 On small or simple installations where there is one plant and one or two zones and therefore little chance of confusing the ducts, it will not be necessary to provide identification other than the colour symbol. On large complex installations with many zones, widely branched distribution systems or several plants, further identification is necessary. In this connection a plant refers to the ductwork and equipment associated with one particular fan.

C.2.8.2 The further information to be given will normally be the space served by the duct and in some cases the associated plant. The information should be given as briefly as possible using commonly accepted forms such as a number indicating which floor of a building. The plant identification should always be preceded by the letter 'P' to avoid confusion between the number of the floor and the number of the plant. The plant itself must be clearly numbered to correspond. Letters for Supply, Flow, Extract, etc., should not be added because identification will be clear from the colour symbol. Thus confusion between 'S' for Supply and 'S' for South will be avoided.

Table 34 Examples of further identification symbols

Code	Information given
9 SW P2	9th Floor, South-West Zone, Plant Two
Comp 2 P2	Computer 2, Plant Two
3 Lab 8 P4	3rd Floor, Laboratory 8, Plant Four
2 Op Th 2P1	2nd Floor, Operating Theatre 2, Plant One
Bay 5 N P5	Bay 5, North end, Plant Five

C.2.8.3 Where identification of the space is by room number, this must be agreed with the user who otherwise may have numbered the rooms differently.

Some examples of further identification systems are given in Table 34.

C.2.8.4 The letters and numbers should be in either black or white, whichever gives the better contrast. They should be marked on the colour symbol or immediately adjacent to it. The size of the figures will depend on how easily they can be seen, but should not be less than 25 mm high.

C.2.9 Explanatory chart

It is recommended that an explanatory chart should be kept in the plant room or other convenient place. The chart should show and explain the colour symbols used on the installation and where appropriate the figure and letter codes used for further identification.

C.3 METHOD OF APPLICATION OF SYMBOLS

C.3.1 Several methods are available for applying the symbols, the main factor being that the symbol is permanently affixed. Suitable methods are:

C.3.1.1 Painting, using stencilled letters and figures.

C.3.1.2 Self-adhesive plastics or transfers with water soluble backing. (It is important to ensure that the surface is smooth and clean and that the adhesion will not deteriorate due to the surrounding atmosphere.)

C.3.1.3 Purpose-made plastics or metal labels.

APPENDIX D – TRANSPORT, HANDLING AND STORAGE OF DUCTWORK

D.1 Transport
Large capacity vehicles such as furniture vans or similar, with high-sided open or closed top bodies, are the most suitable for the transport of ductwork.

D.2 Lengths of ductwork should preferably be positioned so as to avoid crushing. Lengths with projections, such as branches and bends, flanges, girths, damper quadrants, etc., should be packed so as to avoid damage to adjacent duct panels. In some cases, particularly on contracts calling for repetitive sizes, the use of timber jigs and spacers may be justified.

D.3 Where reduced bulk and greater protection are major factors, such as consignments for export, transporting ductwork in 'L' shape sections may justify the increased site assembly costs.

D.4 Handling
Sheet metal ducts are liable to deformation through careless or excessive handling. Such deformation does not normally affect function, but will detract from appearance.

D.5 To minimise damage, duct sections should be clearly identified, and deliveries to site should be closely linked to the installation programme, so as to avoid accumulation of unfixed ductwork and double handling.

D.6 Storage
Adequate floor space must be provided for the site storage of ductwork. Such storage shall make due allowance for the storage of ductwork in stacks such that access between the stacks is of sufficient width to permit the removal of items from one stack without interference to adjoining stacks.

Lengths of ductwork should preferably be positioned so as to avoid crushing. Ductwork of small panel size may be stored horizontally; however, care should be exercised to ensure that stack sizes are limited to within the structural strength of the duct sections to prevent distortions of the lower sections within the stack.

All ductwork should be stored so as to prevent water collecting, clear of ground water and in compounds free from site traffic.

All storage facilities shall be covered and adequately protected against rain and snow. Where tarpaulins are provided as temporary cover, they should be held clear of the ductwork so that air can circulate, and secured in such a manner as to impose no direct load on the ductwork.

Covered storage is important to minimise the formation of the unsightly deposit known as 'white rust', which is a corrosion product formed on the zinc surface where it is in contact with water for a long period from rain or condensation.

While the protective properties of the zinc are not impaired by the presence of **superficial** white rust, it is unsightly and this can result in a rejection of the ductwork so affected.

Small areas of white rust can be removed by abrading with a stiff bristle brush. Large areas can be treated by various proprietary products designed for this purpose, or by simple chemical solutions which can be prepared on site.

Moving parts, such as damper spindles, and accessories liable to corrode, should be greased or otherwise adquately protected. On removal from storage, all ductwork and fittings, etc., should be inspected and cleaned of extraneous materials.

APPENDIX E – DUCTWORK SYSTEMS AND FIRE HAZARDS

E.1 Fire containment and fire hazards are factors which influence the design and installation of ductwork systems. Information concerning the fire protection of ductwork can be found in CP 413 published by the British Standards Institution and in the Technical Memorandum 1 published by the Chartered Institution of Building Services (formerly the Institution of Heating and Ventilating Engineers). Notes on legislation relating to fire and services in buildings are given in CIBS Technical Memorandum 2.

E.2 The principles of fire protection in relation to ductwork are:

E.2.1 Fire dampers should be provided where ducts pass through fire compartment walls. Fire dampers should be framed in such a way as to allow for expansion in the event of fire, and the design must provide for the protection of any packing material included.

E.2.2 If there is no duct opening into the compartment, fire dampers may be omitted at the walls, provided the duct is enclosed by a structure having the same fire resistance as the compartment. In this context, it should be appreciated that **sheet metal alone offers only limited fire resistance and is not a heat barrier.**

E.2.3 The amount of combustible and smoke/fume producing materials used in the construction of ductwork should be limited. This requirement includes in its scope sealants, gaskets and other jointing materials; flexible ducts and joints, insulating and lining materials. The combustible content of construction material is assessed by the fire propagation test specified in BS 476, Part 6.

Standard types of fire dampers and frames are described in Section 23 of this specification.

APPENDIX F – GALVANIZING AFTER MANUFACTURE

F.1 General

F.1.1 For galvanizing after the fabrication of any article it is necessary to appreciate the nature of the process, including the surface preparation of the object to be treated and the precautions to be taken in design, fabrication and handling.

F.1.2 Galvanizing involves dipping the object into a bath of molten zinc (at a temperature of between 445° and 465° C), and it is necessary for the zinc to cover the whole of the surface leaving no gaps in the zinc.

F.2 Design and fabrication

F.2.1 It is well known that fabrication articles will suffer distortion in the course of dipping into the molten zinc bath, due to the introduction of or relief of inherent stress in the steel sheet or of any stresses that may have been built into the item during fabrication, or indeed of any stresses introduced during the handling, loading or unloading of the item. The sheet thicknesses specified in DW/142 for articles to be galvanized after manufacture are calculated to take this factor into account.

F.2.2 It is essential to have a free flow of the molten zinc over the object to be galvanized, together with quick and complete drainage of the molten metal. Because of the high temperature involved, the object to be galvanized should be as rigid as possible, either by the use of sufficiently heavy sheet or by stiffening or bracing, or both.

F.2.3 Any sealed hollow section must be adequately vented in order to obviate any possibility of explosion. Holes in vertical members must be provided diagonally opposite each other, top and bottom of the member.

F.2.4 Vent holes should be of sizes as follows:

Size of hollow section (dia. or side)	*Diameter of vent and drainage holes*
mm	mm
Up to 25	8 *(never less)*
50 to 100	10
100 to 150	20
Over 150	25

F.2.5 Stiffeners should desirably have their corners cropped so as to allow a free flow of zinc. Stiffeners should be rolled steel angle, uncoated.

F.3 Surface preparation before galvanizing

F.3.1 The steel surface to be galvanized must be chemically clean before dipping. This is mainly achieved at the galvanizer's works by pickling in an acid bath and washing before the article goes into the zinc bath. However, the pickling process does not remove grease, oil or oil-based paint, and such substances should be removed by the fabricator by the use of suitable solvents before the object to be treated is delivered to the galvanizing works. Any surface rust that develops on the object between the time of treatment by the fabricator and delivery to the galvanizing works is not important, as this is cleaned off by the acid pickling process.

F.4 Handling and storage after galvanizing

F.4.1 While a galvanized surface will not develop rust in the ordinary sense as long as the zinc coating is undamaged, zinc is subject to what is known as 'white rust,' which is an unsightly and damaging deposit on the zinc surface. White rusting can arise from the stacking of articles when wet, acid vapours, the effect of salt spray, the reaction of rain with flux residues, etc.

F.4.2 Galvanized articles should therefore not be stacked or loaded when wet; they should desirably be transported under cover or shipped in dry, well-ventilated conditions, inserting spacers (but not resinous wood) between the galvanized articles.

F.4.3 When stored on site or elsewhere, care should be taken to avoid resting the galvanized article on cinders or clinker, as the acid content of these substances will attack the zinc surface.

F.5 Subsequent finishing

F.5.1 Paint finishing subsequent to galvanizing is sometimes required either for additional protection or for decorative reasons. It should be noted that the adhesion of paint coatings to new galvanized surfaces is suspect, and either the application of a calcium plumbate based primer direct to the galvanized surface, or a phosphating treatment, is recommended. Advice should be sought from the paint manufacturer.

The above is based on information given in publications available from the

Galvanizers' Association,
34 Berkeley Square, London W1X 6AJ
(Telephone: 01-499 6636)

APPENDIX G – STAINLESS STEEL FOR DUCTWORK

G.1 General

G.1.1 Stainless steel is not a single specific material: it comprises a group of steels with varying composition, but in no case less than 9 per cent of chromium. It is the chromium addition which provides the enhanced corrosion resistance of stainless steels.

G.1.2 Modern stainless steels have a combination of good formability and weldability, and can be supplied with a variety of surface finishes (see G.4.1 below). They have been developed to cover a wide range of structural uses where high resistance to corrosion and low maintenance costs are demanded.

G.1.3 Ductwork applications for which stainless steels are particularly suited include those where a high integrity inert material is essential; where a high degree of hygiene is required; in the chemical industries where toxic or hazardous materials may be contained; in nuclear and marine applications (e.g., on offshore platforms). Stainless steels also find application in exposed ductwork where their finish can be used to aesthetic advantage.

G.2 Grades of stainless steel

G.2.1 The grades of stainless steel used for ductwork applications are among those covered by BS 1449, Part 2. Before a type is specified, the nature of the environment, fabrication requirements, etc., should be taken into account. The types used for ductwork could be the ferritic 400 series (magnetic) or the austenitic 300 series (non-magnetic). The latter contains nickel as well as chromium, and offers the better corrosion resistance.

G.2.2 Some typical stainless steels and their characteristics are described below.

G.2.2.1 Type 409 – 11.5% chromium; 0.3% titanium ('Hyform')

This is a ferritic stainless steel developed as a stainless steel type lower in price than some others, and with forming characteristics similar to those of mild steel. Type 409 is non-hardening by the heat from welding; does not require post-weld treatment; and can be formed using conventional practices.

It is used in mildly corrosive environments, e.g., domestic boilers; automotive exhaust parts; and a wide range of structural applications.

G.2.2.2 Type 304 – 18% chromium; 9% nickel ('Austenitic')

This type is sometimes referred to as '18/8', i.e., 18 per cent chromium and 8 per cent nickel, although the actual composition may vary widely from those figures. It is weldable and has good formability with good general corrosion resistance.

It is used in moderately corrosive environments, storage tanks, process plants, road tankers, etc.

G.2.2.3 Type 316 – 17% chromium; 11% nickel; 2.5% molybdenum ('Austenitic')

This type has very high corrosion resistance and is weldable.

It is particularly useful in aggressive environments such as process plants; marine applications; power generation; etc.

C.3 Availability

G.3.1 Stainless steel is supplied in a wide range of thicknesses, from 0.4 mm for cold-rolled sheet and coil, and from 0.075 mm for precision rolled strip. It is supplied in slit widths as specified by the customer, up to a maximum width of 1525 mm.

G.4 Surface finishes

G.4.1 Stainless steel is available in a wide selection of finishes, varying from fine matt to mirror polished, as defined in BS 1449: Part 2:

Mill finishes

Type 2D	Cold finished, softened and descaled. A uniform matt finish.
Type 2B	Cold rolled, softened, descaled and lightly worked with polished rolls. A smooth finish brighter than 2D.
Type 2A	Bright annealed. A cold finished reflective appearance retained through annealing.

Polished finishes

Type 4	Dull polished. A lustrous uni-directional finish produced by fine grinding, generally with abrasives of 150 grit size. It has little specular reflectivity. Further dull polishing after fabrication will diminish the effects on appearance of welds or accidental damage by blending them into the surrounding metal.
Type 8	Mirror polished. A bright reflective finish with a high degree of image clarity.

C.4.2 Where other finishes are required, such as for aesthetic purposes, colour may be applied in the form of paint or lacquer, or the material may be supplied pre-coloured as by the 'INCO' process.

G.5 Surface protection

G.5.1 No surface protection is required for stainless steel ductwork used indoors or outdoors, provided the correct quality is specified. This is because the naturally occurring chromium-rich oxide film which is present on the surface of the metal, if damaged, reforms immediately by reaction between the steel and the atmospheric or other source of oxygen.

G.5.2 If a mixture of metals is used, such as mild steel supports for stainless steel ductwork, the surface of the mild steel must be adequately protected from the galvanic corrosion that might result from the intimate contact between the two types of metal. (The appropriate protective finish in Table 29 (for outdoor applications) should be employed.)

G.6 Construction

G.6.1 Sheet thicknesses for stainless steel ductwork should be the same as for galvanized steel (see Tables 4, 14 and 15). Where any additional gauge allowance is made for corrosion resistance, this should be based on knowledge of the corrosive influences present in the local environment.

G.6.2 The forming of rectangular and circular ducts can be carried out by the use of conventional press working and sheet metal forming machines. Some alteration in working practices may be necessary, however, depending on the type of stainless steel being used.

G.6.3 As a general rule, the 400 series of stainless steels can be formed using normal mild steel settings. The 300 series, however, because of the higher yield point and the greater rate of work hardening, will require higher working pressures.

G.6.3 Ductwork contractors who have experience of the use of stainless steel report difficulty in forming Pittsburgh and button punch snap lock seams. As regards cross joints, socket and spigot joints are recommended, and one or two of the slide-on flanges are suitable. In view of the foregoing, it is recommended that trials be carried out before starting on production.

G.7 Rectangular ducts

The constructional requirements for rectangular stainless steel ducts are the same as for galvanized mild steel.

G.8 The constructional requirements for circular stainless steel ducts are the same as for galvanized mild steel.

G.9 Stiffening

Wherever possible, the material used for stiffening should be of the same grade of stainless steel as used for the construction of the ducts, or should be made equally corrosion resistant to suit the environment in which the ductwork is situated.

G.10 Fixings and fastenings

The types of fastening and the maximum spacings specified in Table 10 (rectangular) and Table 16 (circular) also apply to stainless steel ductwork.

Fixings and fastenings should be of the appropriate grade of stainless steel as used in the construction of the ductwork, or should be made equally resistant to corrosion in relation to the environment in which the ductwork is situated. The type of stainless steel fastening used should conform to the appropriate specification (e.g., BS 1768, 3692; ISO 3506 – Hexagon bolts, set screws and nuts).

G.11 Welding

All the modern welding processes may be used to weld stainless steel, but tungsten inert gas (TIG) and resistance welding are likely to be the most suitable for light-gauge materials. Attention is drawn to BS 4872: Part 1 when welding stainless steels; and to BS 2901 for the selection of filler rods and wires.

When welding dissimilar metals, e.g., mild steel to stainless steel, **the choice of the electrode is very important**, as the effect of dilution of the weld metal by the base metal must be considered. Reference should be made to BS 2901: Parts 1 and 2, and to BS 2926 for selection of welding electrodes.

G.12 Fire dampers

Stainless steel is an ideal material for use in the construction of fire dampers, due to its high resistance both to heat and corrosion. It is therefore most applicable where a fire authority makes corrosion resistance a requirement.

G.13 Sealants, gaskets and tapes

The sealing materials and methods set out in this specification are also applicable to stainless steel ductwork. However, any **chloride-based material, such as polyvinyl chloride (PVC), should be avoided**, as breakdown of such materials at certain elevated temperatures could lead to corrosion of the stainless steel.

G.14 General design considerations

It is the designer's responsibility to indicate the type of stainless steel most suitable for the conditions in which the ductwork is to be exposed. If users and designers are in doubt as to which material is appropriate to a particular application, technical advice may be obtained from the source noted below.

This appendix is based largely on information
kindly supplied by the
British Steel Corporation,
Stainless Steel Advisory Centre,
P.O. Box 161,
Shepcote Lane,
Sheffield S9 1TR
(Telephone: 0742 440060/441224)

APPENDIX H – PRE-COATED STEEL

H.1 Nature of the material

H.1.1 'Pre-coated' steel is sheet, coil or strip to which has been applied at the steel mills a coating having a decorative or protective function, or both.

H.1.2 The basis metal to which the coatings are applied are hot-dip galvanized sheet or coil, uncoated steel or electro-galvanized steel (e.g., Zintec).

H.2 Range of coatings available

H.2.1 A number of different types of coating, in various thicknesses, are available – PVC ('plastisol' and 'organosol'); paint coatings of several types, silicone enamels, etc.

H.2.2 A wide range of colours and surface finished are available, but there are minimum quantity requirements for some types of coating, finish and colour. The characteristics of the particular type of coating contemplated for a particular use should be investigated in respect of formability, fastness to light, chemical resistance and other relevant properties.

H.2.3 The material can be supplied with one or both sides treated.

H.3 Sizes available

H.3.1 Pre-coated steel is available in sheet or coil form – sheet in widths from 610 mm to 1370 mm and in length up to 5486 mm. Coil is supplied in widths from 610 mm up to 1370 mm. The maximum available width can vary also according to the steel thickess required. Availability varies according to type of substrate and coating, so prospective purchasers should query the sizes available for the specific type required.

H.4 Sources of supply

H.4.1 Pre-coated steel is obtainable from major steel stock-holders or direct from the British Steel Corporation.

H.5 Ductwork construction from pre-coated steel

H.5.1 The type of pre-coated steel most suitable for ductwork should be carefully considered, mainly from the point of view of the fabrication properties of the coating type. It is probable that a plastisol coating will be found to be most suitable for ductwork, as this type of coating will withstand an Ot bend at normal ambient temperatures. It also tolerates rougher handling during forming and erection than the much thinner paint coating types.

H.5.2 Careful consideration should be given to the constructional methods to be used for ductwork to be made from pre-coated steel. The principle to be followed should be to make seams and joints as unobtrusive as possible. Some of the conventional methods of seaming may be used, but a number of others are not suitable. Welding with conventional equipment should not be attempted. Mechanical fastenings should be chosen with care having regard to appearance as well as efficiency; and sealant should be applied with these factors in mind. Stiffening should be carefully considered in relation to appearance.

H.6 Handling, storage, transport and erection

H.6.1 Much more care than usual is required in these respects, as the coatings are all to a greater or lesser degree susceptible to mechanical damage. For example, sheet should not be dragged off the top of a pile but removed by 'turning' off the stack.

H.6.2 With sheet pre-coated on one side only, it may be found desirable to stack face to face.

H.6.3 The flexibility of coatings of the types used on pre-coated steel depends on temperature. Therefore, manipulation should be carried out at temperatures above 16°C (60°F) in order to prevent the film cracking on roll forming, etc. If the material has been stored outside at low temperature, a warm-up period should be allowed before manipulation of the sheet is undertaken.

The information on which this appendix is based has been kindly supplied mainly by the British Steel Corporation. More detailed information may be obtained from:

British Steel Corporation,
Product Development Centre,
Shotton Works,
Deeside,
Clwyd CH5 2NH
Telephone: Chester (0244) 812345
Telex: 61241

APPENDIX J – ALUMINIUM DUCTWORK

J.1 Suitable grades

J.1.1 Ductwork can be constructed from all the commonly used aluminium alloys, the choice depending on the purpose for which the ducts will be used and the service environment.

J.1.2 The alloys 1200, 3103 and 5251 (as specified in BS 1470) are easy to form and to join, and have excellent resistance to atmospheric corrosion, with 5251 being rather more resistant to marine atmospheres.

J.1.3 These alloys can be supplied in various tempers produced by different degrees of cold rolling, so that a range of strengths is available. In choosing a temper, it is necessary to consider any forming that will be done, as with the harder tempers the forming of tight bends might cause cracking. Where high strength is required, alloy 6082-TF sheet can be used.

J.1.4 Aluminium strip is also available in the form of pre-painted coil.

J.2 Construction

J.2.1 The general constructional requirements for aluminium ductwork are set out in Section 20.

J.2.2 Where possible, aluminium bolts and rivets should be used. Stainless steel fasteners are also suitable, as are galvanized steel bolts as long as the zinc coating remains intact. Joints liable to entrap moisture should be coated with a zinc chromate primer before assembly.

J.2.3 All the aluminium alloys can be welded by MIG or TIG methods, with argon as the shielding gas. Helium or a mixture of helium and argon can be used, but not CO_2. Alloys in a work-hardened temper are reduced to the annealed condition in the heat affected zone; 6082-TF is reduced approximately from the TF to the TB temper. Alloys 1200 and 3103 are easy to braze, as is 6082, but the latter needs to be re-heat treated to regain its strength.

J.3 Protective finishes

J.3.1 In moist atmospheres, particularly if they are contaminated by industrial effluent or by salt from the sea, surfaces not exposed to washing by rain will become roughened and covered with a layer of white corrosion product. However, this has the effect of sealing the surface against further attack, and the mechanical properties of any but the thinnest of materials will be only slightly affected.

J.3.2 If the surface needs to be protected, any of the normal organic finishes can be used, including the laminated PVC films, although paints with heavy metal pigments are not suitable. The use of pre-painted strip in coil form provides a reliable quality finish and often proves more economical than painting after assembly. Anodising provides an excellent finish for aluminium, but this process would have to be carried out after forming and would therefore not usually be practicable for ductwork, except perhaps for ducts formed from extrusions.

This appendix is based on material kindly supplied by the Aluminium Federation Ltd., Broadway House, Calthorpe Road, Five Ways, Birmingham B15 1TN (telephone: 021-455 0311), from whom more detailed information may be obtained.

APPENDIX K – EUROVENT

K.1 General

Reference is made in Section 6 and Appendix A herein to EUROVENT and some explanation of the function, composition, objectives and membership of that body is therefore needed.

K.2 Membership

EUROVENT is an omnibus word standing for the European Committee of the Construction of Air Handling Equipment. It was formed in 1959, and in 1977 its constituent members were the relevant national associations in Austria, Belgium, Denmark, Finland, France, German Federal Republic, Italy, Netherlands, Norway, Sweden, Switzerland and the United Kingdom.

K.3 Objectives

The objectives of EUROVENT are 'to improve and develop technical matters in the manufacture and operation of air handling equipment; to improve the professional status of its members and to facilitate commercial exchanges between its member nations in the search for improved quality; and the adoption of rules, directives and codes of practice in the technical and economic spheres in the member countries'.

K.4 UK representation

Membership of EUROVENT is restricted to one body in each of the countries listed in K.2 above. As EUROVENT is largely concerned with the manufacture of equipment, the UK representative is the HEVAC Association. As regards ductwork, the Duct Work Group of HVCA during 1975 formally affiliated to the HEVAC Association, thus giving the Group a direct voice in EUROVENT ductwork projects.

K.5 EUROVENT publications

EUROVENT has published a number of documents in the air handling field, and these include Document 2/3 covering the standardisation of duct sizes. Document 2/2 covers the procedure for testing for air leakage in ductwork, and provides for two levels of permissible air leakage for low-pressure air distribution systems.

K.6 EUROVENT Document 2/3 – standard sizes of ducts

This gives a range of standard sizes for both rectangular and circular ducts.

As regards rectangular ducts, the Duct Work Group has adopted the EUROVENT recommendations see Table 3 on page 13 of this specification.

As regards circular ducts, most of the spirally-wound circular ducts in the UK are made on forming heads based on Imperial measurements. It is now common practice for these Imperial sizes to be quoted in metric units, but the conversion is a 'soft' one, and thus in the larger diameters there is a significant discrepancy between the nominal quoted dimensions and the actual ones. For this reason, the nominal diameters of the circular ducts have been given separately in Table 13.

K.7 Possible ISO standard for duct sizes

In 1974 EUROVENT proposed to the International Standards Organisation (ISO) that the standard sizes specified in Document 2/3 be converted into an International Standard.

The ISO, as in duty bound, referred the proposal to the various national standardising bodies – in the case of the UK the British Standards Institution.

At the time of preparing this ductwork specification, a representative committee of the BSI (including representatives of the HEVAC Association and of the Duct Work Group of HVCA) was considering the matter.

K.8 Air leakage

The basis on which air leakage is calculated in EUROVENT Document 2/2 has been adopted in DW/142, with the exception that the leakage limits in Document 2/2 relate to the pressure classes A, B and C (see Section 6 of DW/142), while DW/142 includes a limit for Class D – high-pressure ductwork up to 2500 Pa.

Information about EUROVENT may be obtained from the HEVAC Association, Unit 3, Phoenix House, Phoenix Way, Heston, Middx. TW5 9ND (Telephone: 01-897 2848)

APPENDIX L – SUMMARY OF BS 2989: 1975

Note – The extracts from BS 2989: 1982 have been prepared by the HVCA and are included here by courtesy of the British Standards Institution.

L.1 GENERAL

L.1.1 The BS 2989: 1975 ('Hot-dip zinc coated steel sheet and coil') summarised in DW/141 has been superseded by the 1982 edition, which is entitled 'Continuously hot-dip zinc coated and iron-zinc alloy coated steel: wide strip, sheet/plate and slit wide strip'.

L.1.2 Comparison of the following with Appendix D of DW/141 will show changes in type references.

L.1.3 As before, the new British Standard sets out requirements for the conventional galvanized sheet and coil (and now also strip) and for iron-zinc coated steel. (Both these are included in DW/142 – see Section 7.)

The type of steel normally used for ductwork is Z2 G.275 (under the previous British Standard designated as Z2, coating type C).

L.2 STEEL GRADES

L.2.1 BS 2989: 1982 lists the grades of steel set out in the next column, among others:

Grade	*Name of grade*	*Application*
Z1	Commercial quality	Forming quality steel suitable for simple bending and forming operations
Z2	Bending and profiling quality	Forming quality steel suitable for the manufacture of most profiles and more difficult bending operations
Z3	Drawing quality	Forming quality steel suitable for simple drawing operations and for more difficult profiling operations
Z4	Special drawing quality	Forming quality steel suitable for deep drawing and difficult forming operations
Z5	Special drawing quality, non-ageing	Forming quality steel suitable for deep drawing and difficult forming operations where a non-ageing steel is required

L.3 COATING TYPES

L.3.1 The types of zinc coating are set out in Table 9 of BS 2989: 1982 (reproduced at the foot of this page).

L.4 SURFACE FINISHES

L.4.1 BS 2989 includes a description of the various types of finish available:

Normal spangle (N). A zinc coating finish, having a metallic lustre, that is the result of unrestricted growth of the zinc crystals during normal solidification.

NOTE. Normal spangle is the type normally supplied for a wide variety of applications.

Minimized spangle (M). A zinc coating finish, normally supplied with zinc coatings in the range G100 to G350, that is obtained by restricting the normal zinc crystal formation.

Regular finish (R). The normal iron-zinc alloy coating finish; it is grey matt in appearance and shows no spangle.

Smooth finish (S). A finish suitable for decorative painting that is available for zinc coatings up to G350 and iron-zinc alloy coatings.

Extra smooth finish (XS). A coating finish, produced by rolling processes after coating and available for zinc coatings up to G275 and for iron-zinc alloy coatings, suitable for applications where a high gloss painted finish is required.

L.5 SURFACE PROTECTION

L.5.1 All types of coating normally receive a surface protection at the producer's plant.

This may consist of chemical passivation; or oiling; or chemical passivation and oiling. The purchaser should state on his order the treatment required.

L.4.2 Chemical passivation and/or oiling protects the surface against humidity and reduces the risk of formation of wet storage stains (so-called 'white rust'). However, the protection afforded is limited. If the purchaser specifies non-protected products, the manufacturer is not responsible for the formation of any storage stains. (Chemical passivation may cause slight discoloration of the surface that is not detrimental to the general performance of the product.)

L.6 FORMING

L.6.1 The British Standard says that provided that the profiling machine is set to avoid excessive stretching in the product, it is possible to form lock seams successfully with Z2 sheet up to a thickness of 1.5 mm and Z3 sheet up to 2 mm; and snap lock seams with Z2 up to 0.9 mm thick sheet and Z3 sheet up to 2 mm.

L.7 WELDING

L.7.1 Care should be taken to use proper methods and procedures. The iron-zinc coating is more suitable for resistance welding than the conventional zinc coating.

Table 9 (of BS 2989) Coating mass (weight)

Coating designation	Minimum coating mass (including both sides)		Suggested applications *(see note 2)*
	Triple spot test	Single spot test	
	g/m²	g/m²	
Zinc coatings (G)			
G100	100	85	Light – for use where corrosion conditions are not severe and/or where forming operations preclude heavier coatings.
G200	200	170	
G275	275	235	Standard
G350	350	300	Heavy duty – for longer life relative to standard and light coatings.
G450	450	385	
G600	600	510	
Iron-zinc alloy coatings (IZ)			
IZ100	100	85	Iron-zinc alloys – alloyed coatings of iron and zinc for easy painting and particularly resistance welding.
IZ180	180	150	

Note 1. The mass of zinc is not always evenly divided between the two surfaces of the sheet. However, it can normally be expected that not less than 40% of the specified minimum coating mass, as determined by the single spot test, will be found on each surface.

Note 2. The suggested applications included in the right-hand column of the above table are those put forward by the British Steel Corporation.

APPENDIX M – 'DESIGN NOTES FOR DUCTWORK' (CIBS Technical Memorandum No. 8)

M.1 This manual brings together information on the design of ductwork systems.

M.2 The contents have been drawn from the current relevant sections of the CIBS Guide and other recognised references, and include additional material on good design practice. The Notes make frequent reference to DW/142, and an effort has been made to ensure consistency between the two publications. The Design Notes include chapters on:

Pressure loss in ducts, including corrections for duct surface type, air pressure, air density, temperature and altitude, and loss factors for fittings.

Equivalent diameters of rectangular and flat oval ducts.

Standard dimensions of circular, rectangular and flat oval ducts.

Duct sizing methods, including velocity, equal-friction and static regain methods, and pressure loss calculations, with an example calculation.

Heat loss from and gain to air in the duct; condensation, noise control and fire.

Commissioning and testing.

Overseas work.

Drawing symbols in current use.

M.3 The flow of heavily contaminated air in ducts is not covered in detail in the Notes; nor are the constructional aspects of ductwork, which are dealt with in DW/142.

M.4 The Notes are completed by references, a bibliography of over thirty titles and appendices covering properties of air, ductwork support loads, velocity pressure for air flow and conversion to SI units.

These notes have been contributed by the Chartered Institution of Building Services, Delta House, 222 Balham High Road, London SW12 9BS (Telephone: 01-675 5211)

APPENDIX N – BIBLIOGRAPHY

Included in this Bibliography are technical publications which may be of interest to ductwork designers, fabricators and erectors, and to those in the heating, ventilating, air conditioning industries generally. Enquiries should be made of the relevant organisation, at the address quoted.

HEATING AND VENTILATING CONTRACTORS' ASSOCIATION

34 Palace Court, London W2 4JG *Telephone:* 01-229 2488; *Telex:* 27929. *Orders to* HVCA Publications, Old Mansion House, Eamont Bridge, Penrith. Cumbria CA10 2BX (*Telephone:* 0768 64771 *Telex:* 64326)

Ductwork

DW/142	Specification for sheet metal ductwork (low-, medium- and high-pressure) (1982)
DW/143	A practical guide to ductwork leakage testing (1983)

Other technical publications

TR/5	Welding of carbon steel pipework (1980) – 'The Grey Book'
TR/3	Brazing and bronze welding of copper pipework and sheet (1976) – 'The Copper Book'
TR/6	Guide to Good Practice for Site Pressure Testing of Pipework (1980)

CHARTERED INSTITUTION OF BUILDING SERVICES

Delta House, 222 Balham High Road; London SW12 9BS (*Telephone:* 01-675 5211)

CIBS Guide

Volume A	Design Data
Volume B	Installation and Equipment Data
Volume C	Reference Data

Commissioning Codes

These Codes cover the preliminary checks, setting to work and regulation of various categories of plant. The Codes give a guide to design implications.

Series A	Air Distribution Systems
Series B	Boiler Plant
Series C	Automatic Control Systems
Series R	Refrigerating Systems
Series W	Water Distribution Systems

Technical Memoranda

No. 1	Recommendations relating the design of air-handling systems to fire and smoke control in buildings
No. 2	Notes on legislation relating to fire and services in buildings
No. 3	Notes on legislation relating to the Health and Safety at Work etc. Act, 1974
No. 4	Design Notes for the Middle East
No. 5	The calculation and use of utilisation factors
No. 6	Lighting for Visual Display Units
No. 7	Recommendations on the use of small programmable calculators
No. 8	Design Notes for Ductwork
No. 9	Notes on Non-Statutory Codes and Standards, relating to Fire and Services in Buildings

BUILDING SERVICES RESEARCH AND INFORMATION ASSOCIATION

Old Bracknell Lane West, Bracknell, Berkshire RG12 4AH (*Telephone:* Bracknell (0344) 26511; *Telex: 848288 BSRIAC G)*

Application Guides

AG.1/74	Designing Variable Volume Systems for Room Air Movement

HEVAC ASSOCIATION

Unit 3, Phoenix House, Phoenix Way, Heston, Middx. TW5 9ND (*Telephone:* 01-897 2848)

Fan Application Guide *(Second Edition 1982)*

Guide to Air Diffusion

Guide to Central Station Air Handling Units

Guide to Elimination of Noise in Fan Systems

EUROVENT publications *(enquiries to the HEVAC Assocation)*

1/1	Fan terminology
2/1	Vocabulary relative to air distribution and air diffusion
2/2	Air leakage rate in sheet metal air distribution systems
2/3	Sheet metal air ducts – standard for dimensions
AG.1/75	Manual for Regulating Air Conditioning Installations
AG.1/77	Documents for Air System Regulation
AG.2/75	Room Air Movement with Ceiling Mounted Diffusers – Influence of Cold Windows

Laboratory Reports

LR.65	Air Movement in Rooms with Side-wall Mounted Grilles
LR.71	Air Movement in Rooms with Sill-Mounted Grilles – Design Procedure
LR.75	Air Flow Generated Noise: Part 1: Grilles and Dampers
LR.78	Air Flow Generated Noise: Part 2: Bends with Turning Vanes
LR.79	The Effect of Ceiling Beams and Light Fittings on Ventilating Jets
LR.80	Air Movement in Rooms with Ceiling Mounted Diffusers
LR.83	Air Movement in Rooms with Low Air Supply Rates

BRITISH STANDARDS INSTITUTION

Sales Department, 101 Pentonville Road, London N1 9ND *(Telephone:* 01-837 8801)

DD 5:1971	Recommendations for metric plate and sheet thickness and width/length combinations for metallic materials
DD 24:1973	Recommendations for methods of protection against corrosion on light section steel used in building
BS 381C:1964	Colours (of ready-mixed paints) for specific purposes
CP 413:1973	Ducts for building services
BS 476:	Fire tests on building materials and structures
Part 1:1953	*(Superseded by Part 8)*
Part 2:1955	*(Withdrawn)*
Part 3:1975	External fire exposure roof test
Part 4:1970	Non-combustibility test for materials
Part 5:1968	Ignitability test for materials
Part 6:1968	Fire propagation test for materials
Part 7:1971	Surface spread of flame tests for materials
Part 8:1972	Test methods and criteria for the fire resistance of building construction
BS 729:1971	Hot dip galvanized coatings for iron and steel articles
BS 1449:	Steel plate, sheet and strip
Part 1:1972	Carbon steel plate, sheet and strip
BS 1470:1972	Wrought aluminium and aluminium alloys for general engineering purposes – plate, sheet and strip
BS 1474:1972	Wrought aluminium and aluminium alloys – bars, tubes and sections
BS 2569:	Sprayed metal coatings
Part 1:1964	Protection of iron and steel by aluminium and zinc against atmospheric corrosion
Part 2:1965	Protection of iron and steel against corrosion and oxidation at elevated temperatures
BS 2989:1982	Continuously hot-dip zinc coated and iron-zinc alloy coated steel
BS 3533:1962	Glossary of terms relating to thermal insulation
BS 4174:1972	Self-tapping screws and metallic drive screws
BS 4342:1968	Glossary of terms used in mechanised and hand sheet metal work and metal box making
BS 4800:1972	Paint colours for building purposes
BS 4848:	Hot rolled structural steel sections
Part4:1972	Equal and unequal angles
BS 5422:1977	Specification for the use of thermal insulating materials
BS 5720:1979	Code of practice for mechanical ventilating and air conditioning in buildings
BS 5970:1981	Code of practice for thermal insulation of pipework

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION INC. (SMACNA)

8224 Old Courthouse Road, Tyson's Corner, Vienna, Virginia 22180, U.S.A. *(Telephone:* 703-790 9890)

Architectural sheet metal manual (1979)
Architectural sheet metal specifications (1980)
Balancing and adjustment of air distribution (1967)
Contractor's Handbook for Air Pollution Control
Duct liner application standards (1975)
Fibrous glass duct construction standards (1979)
Fire Damper and Heat Stop Guide (1981)
Flexible Duct Performance and Installation Standard (1981)
Guidelines for energy conservation in existing buildings (1974)
Guidelines for energy conservation systems in new building (1975)
Guidelines for Welding Sheet Metal (1977)
High-pressure duct construction standards (1975)
HVAC Duct Design Manual (1981)
Industrial ventilation – manual for recommended practices (1980)
Low-velocity duct construction standards (1976)
Rectangular Industrial Duct Construction Standard (1980)
Round Industrial Duct Construction Standard (1977)
Testing, balancing and adjusting of environmental systems (1974)
Thermoplastic duct (PVC) construction manual (1974)

DEPARTMENT OF THE ENVIRONMENT (Property Services Agency)

H.M. Stationery Office, 49 High Holborn, London WC1Y 6HB *(Telephone:* 01-928 1321) and branches

M & E No.1 1972	Electrical installations in buildings
M & E No.2 1968	Electrical distribution systems external to buildings
M & E No.3 1977	Heating, hot and cold water, steam and gas installations for buildings
M & E No.4 1970	Central heating and hot and cold water installations for dwellings
M & E No.5 1969	Electrical installations in dwellings of traditional construction
M & E No.6 1971	Mechanical ventilation for buildings

TECHNICAL INSTRUCTIONS (M&E) MAINTENANCE

4	Maintenance of Diesel Engines (1970)
8	Planned Maintenance and Operation of Mechanical and Electrical Services (1968)
14	Inspection and Testing of Electrical Wiring Installations and Power Consuming Apparatus (1968)

APPENDIX P

CONVERSION TABLES

Sheet thicknesses

Equivalents reproduced by courtesy of the Metrication Board

Galvanized steel			
Standard thickness		Birmingham Gauge	
inch	mm	BG	inch
.0197	**0.5**	**26**	.0196
.0236	**0.6**	**24**	.0248
.0276	**0.7**		
.0315	**0.8**	**22**	.0312
.0354	**0.9**		
.0394	**1.0**	**20**	.0392
.0472	**1.2**		
		18	.0495
.0630	**1.6**	**16**	.0625
.0787	**2.0**	**14**	.0785
.0984	**2.5**	**12**	.0991

0.5 mm is a standard thickness for galvanized sheet only

2.5 mm is a standard thickness for hot-rolled sheet only

Aluminium			
Standard thickness		Standard Wire Gauge	
inch	mm	swg	inch
		26	.018
.0197	**0.5**		
		24	.022
.0236	**0.6**		
.0276	**0.7**	**22**	.028
.0315	**0.8**		
.0354	**0.9**	**20**	.036
.0394	**1.0**		
.0472	**1.2**	**18**	.048
.0630	**1.6**	**16**	.064
.0787	**2.0**	**14**	.080
.0984	**2.5**		
		12	.104
.1181	**3.0**		
		10	.128

Some miscellaneous conversion factors

To convert	*Multiply by*	*To convert*	*Multiply by*
Length			
Inches to millimetres	25.40	Millimetres to inches	0.03937
Feet to metres	0.3048	Metres to feet	3.281
Area			
Square inches to square millimetres	645.2	Square millimetres to square inches	0.00155
Square feet to square metres	0.0929	Square metres to square feet	10.764
Volume			
Cubic feet to cubic metres	0.02832	Cubic metres to cubic feet	35.315
Cubic feet to litres	28.31	Litres to cubic feet	0.0353
Gallons (UK) to litres	4.546	Litres to gallons (UK)	0.22
Mass			
Ounces to grams	28.35	Grams to ounces	0.03527
Pounds to kilograms	0.4536	Kilograms to pounds	2.205
Tons to tonnes	1.016	Tonnes to tons	0.9842
Volume flow			
Cubic feet per minute to cubic metres per second	0.000472	Cubic metres per second to cubic feet per minute	2119
Cubic feet per minute to litres per second	0.4719	Litres per second to cubic feet per minute	2.119
Motion			
Feet per minute to metres per second	0.00508	Metres per second to feet per minute	197
Pressure			
Inches water gauge to millibars	2.491		
Inches water gauge to pascals (Pa)	249.1		

1 Pa = 1 Newton per square metre = 10^{-2} millibars

Length conversions

The figure in the central column can be read as either the metric or the British measure. For example, 1 millimetre = 0.03937 inch; or 1 inch = 25.4 millimetres.

0.794	1/32	
1.587	1/16	
3.175	1/8	
4.763	3/16	
6.350	1/4	
7.938	5/16	
9.525	3/8	
11.112	7/16	
12.700	1/2	
14.290	9/16	
15.876	5/8	
17.462	11/16	
19.050	3/4	
20.636	13/16	
22.222	7/8	
23.809	15/16	
25.4	**1**	**0.03937**
50.8	2	0.07874
76.2	3	0.11811
101.6	4	0.15748
127.0	5	0.19685
152.4	6	0.23622
177.8	7	0.27559
203.2	8	0.31496
228.6	9	0.35433
254.0	**10**	**0.39370**
279.4	11	0.43307
304.8	12	0.47244
330.2	13	0.51181
355.6	14	0.55118
381.0	15	0.59055
406.4	16	0.62992
431.8	17	0.66929
457.2	18	0.70866
482.6	19	0.74803
508.0	20	0.78740
635.0	25	0.98425
762.0	30	1.18110
889.0	35	1.37795
1016	40	1.57480
1143	45	1.77165
1270	50	1.96850
1397	55	2.16535
1524	60	2.36220
1651	65	2.55905
1778	70	2.75590
1905	75	2.95275
2032	80	3.14960
2159	85	3.34645
2286	90	3.54330
2413	95	3.74015
2540	**100**	**3.9370**
3810	150	5.9055
5080	200	7.8740
6350	250	9.8425
7620	300	11.8110
8890	350	13.7795
10160	400	15.7480
11430	450	17.7165
12700	500	19.685
15240	600	23.622
17780	700	27.559
20320	800	31.496
22860	900	35.433
25400	**1000**	**39.370**

Standard dimensions of steel and aluminium sheet

Steel (black and galvanised)	
Metric	Equivalent
mm	ft/in
2000 × 1000	6' 6 3/4" × 3' 3 3/8"
2500 × 1250	8' 2 7/16" × 4' 1 1/4"
3000 × 1350	9' 10 1/8" × 4' 5 1/8"
3000 × 1500*	9' 10 1/8" × 4' 11 1/16"

** Not readily available*

Aluminium (commercially pure and alloy)	
Metric	Equivalent
mm	ft/in
2000 × 1000	6' 6 3/4" × 3' 3 3/8"
2500 × 1250	8' 2 7/16" × 4' 1 1/4"
3750 × 1250*	12' 3 5/8" × 4' 1 1/4"

*Not available in all gauges or all purities and alloys

Weight of galvanized steel sheet

Thickness	*Weight per square metre*
mm	kg
0.5	3.9213
0.6	4.7056
0.7	5.4898
0.8	6.2741
0.9	7.0584
1.0	7.8426
1.2	9.4111
1.6	12.5481
2.0	15.6852
2.5	19.6064