Luka®
Nederlandse Vereniging van
Luchtkanalenfabrikanten

Quality Guide

Air duct systems 09-2024

Table of contents

Chapter 1.0 General

1.1 Foreword

At the time of publication of this quality Guide Luka, in close cooperation with TÜV Rheinland Nederland B.V. and suppliers of air ducts and fittings, has updated the installation instructions and airtightness requirements for air ducts and fittings, based in part on NEN-EN standards.

Coupled with the Class ATC 3 airtightness requirements for air ducts and fittings, Luka can offer the option to certify the air duct system, from the air handling unit to the discharge ornaments, or the air transport route.

In addition, further technical developments and internationalisation of standards have prompted the Board to request the CET to update the quality Guide accordingly. With this updated Guide the Committee (CET) is confident that they are able to make an important contribution to the transfer of technical knowledge.

This book will also serve as a basis for the quality characteristics of the products and services guaranteed by Luka members and Luka associated members. Furthermore, clear insight is given into the continuous quality approach of all members and the method of quality control by the independent institute TÜV Rheinland Nederland B.V., partner of Luka.

With this publication the committee (CET) hopes to have realized yet another added value for the aerospace branch. Luka and those who have contributed to the compilation of this Guide, have exercised the greatest possible care when collecting, processing and compiling the information contained in this Guide.

Nevertheless, the possibility that this Guide is incomplete or contains errors or omissions should not be ruled out. The use of this Guide and the information contained therein is at the risk of the user.

Luka and those who have cooperated in the compilation of this Guide, rule out every liability for both damages that might result from the use of this information, as well as damages that may arise as a result of the incompleteness, inaccuracy or incompleteness of this Guide.

1.2 Goal of Luka

The primary goal of the association is to promote the technical development of air duct systems in all its aspects.

This goal is achieved by:

a) drawing up quality standards for the manufacture and assembly of air ducts; this also applies to the assembly of fittings and the airtightness of the systems.
b) monitoring the quality of the air duct systems manufactured or assembled by Luka members, by applying rules on the monitoring of compliance with the standards referred to and by drawing up penalties in the event of non- compliance with those standards and/or control provisions.
c) regular checks on compliance with the standards by independent quality officers of TÜV Rheinland Nederland B.V.
(d) cooperation with other organisations or groupings, working in the same or related fields, while also seeking to adopt Joint Contract Terms with Installers.
e) issuing a quality certificate, at the request of its members, for installed ductwork, or for the entire air transport route.
f) compliance with safety and environmental requirements and quality awareness.
g) increasing professional competence by providing and maintaining mechanic and chief mechanic training by Luka teachers or by recognised training institutes.

Luka knows ordinary and associate members.

Ordinary members are Dutch companies which are wholly or partly engaged in the manufacture and sale, purchase and/or assembly of air ducts.

Associate members are Dutch companies wholly or partly engaged in the manufacture or supply of air technical fittings for the air transport route.

The air ducts can be manufactured from galvanised steel, aluminium, stainless steel, plastic, mineral wool or hard foam.

Luka members have special expertise in the manufacture and assembly of air duct systems and occupy a leading position because of their reliability and reputation as quality guarantors. The propagation of quality awareness in the application of production methods, materials to be processed and the checking whether the delivered products meet the Luka quality standards is of decisive importance for the Luka members in their market approach.

The association appoints a working group "Committee Environment & Technology" from its members, which is concerned with the coordination, improvement and updating of quality standards and regulations, both national and international. In addition, the association appoints a working group "Committee for Training" from its members, which deals with the training of mechanics in all its facets.

1.3 Objectives

With this Quality Guide, Luka members once again aim to improve the quality policy in the field of air duct systems. Both members, as well as associated members, are aware that a good quality policy is an integral part of the company policy to be pursued.

This Quality Guide lays down the implementation standards used by the members and is in accordance with the standards referred to in the Annex, which is a list of NEN-EN (European) standards relating to, among others, ventilation.

Luka members have committed themselves to subjecting their products and assembled systems to independent quality inspections. These inspections are carried out by quality officials of the independent institute TÜV Rheinland Nederland B.V. and mainly concern:

- the quality of the materials to be processed, of the products being processed and of the semi-finished and finished products;
- the quality of the materials produced and stored;
- the quality of the assembled air duct systems;
- the result of the air density measurements.

Luka associated members have committed themselves to subject their products (fittings) to independent quality inspections. These inspections or airtightness measurements are carried out by quality officers of TÜV Rheinland Nederland B.V. or by recognised, accredited national or international inspection institutes and concern the measurement set-up, the measurement method and/or the results of the airtightness measurements.

Luka members have their own quality system, based on or derived from the updated ISO 9001.
The installing members have the safety management system according to the latest VCA standards.

In order to increase the competence of air duct mechanics, Luka has developed courses on the levels of:

- mechanic;
- chief mechanic.

In these courses, issues such as safety, quality assurance, organization, capacity, communication, reporting, product knowledge, environment and drawing are addressed. Professional competence on the shop floor is an extra guarantee to further increase the quality level of the air duct systems.

The quality requirements resulting from the quality standards are unambiguously recorded and are independently checked during all phases of implementation by TÜV Rheinland Nederland B.V.

Chapter 2.0 Air duct quality standards

2.1 Rectangular ducts galvanised steel

2.1.1 Sheet quality
For the manufacture of galvanised air ducts, sheet steel is used with anti-corrosion zinc-based coatings, applied using the Sendzimir process, in the qualities:

DX51D Z 275 MAC with a two-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 20 microns per side). Sheet quality/zinc quality according to NEN-EN 10346, tolerances according to NEN-EN 10143.

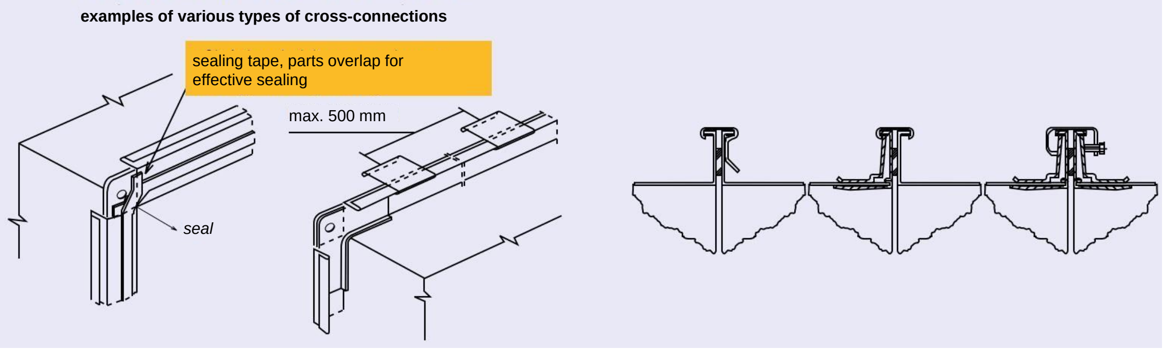
DX51D Z 275 AC with a two-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 10 microns per side). Sheet quality/zinc quality in accordance with NEN-EN 10346, tolerances in accordance with EN 10143.

2.1.2 Sheet thickness
Galvanised air ducts are manufactured with a sheet thickness which depends on the largest duct side, as specified below. For these thicknesses the ducts are manufactured in such a way that sufficient stiffness against deformations and troublesome vibrations is present. The minimum sheet thickness is based on the largest duct side:

	to	≤ 250 mm	= 0.50 mm
> 250 mm	to	≤ 500 mm	= 0.75 mm
> 500 mm	to	≤ 1000mm	= 0.88 mm
> 1000mm	to	≤ 1500 mm	= 1.00 mm
> 1500mm			= 1.20 mm

2.1.3 Cross-connections

In rectangular air ducts, different types of cross-connections can be used. These are company specific, whereby the quality of the sheet, from which the connection profiles are formed, at least complies with that of the material from which the duct is manufactured.



Any sliding frames applied should have a minimum double-sided zinc layer of 140 g/m². These cross-connections may (depending on the company) be rolled to the duct or fastened to the duct by means of push-throughs, spot-welds, parkers or pop rivets. The cross-connections are fixed with clips, sliding strips or clamps with a maximum centre-to-centre distance of 500 mm (see illustration).
A closed-cell sealing tape should be fitted between the cross-connections for airtightness purposes, the minimum dimension being B x H = 18 x 4 mm. All four corners shall be fitted with galvanised bolts and nuts, minimum M 6 x 20. If sliding strips are used for the full circumference of the duct, the bolts and nuts at the corners can be omitted. Where necessary, an internal or external plastic sealant will be applied to ensure airtightness.

2.1.4 Longitudinal connections

Longitudinal connections between duct sections are generally made using a flange connection. Where necessary, plastic sealant is applied internally or externally to ensure airtightness.

2.1.5 Stiffening

The stiffening of air ducts must be such that no troublesome vibrations or deformations occur. This applies to rectangular metal ducts if the largest cross- sectional dimension is ≤ 400 mm, assuming that the minimum recommended thickness of the sheets according to 2.1.1.2 is applied. If these dimensions are exceeded,
additional provisions are required. The degree to which these dimensions are exceeded determines the type of construction of the facilities. For ducts with a side length of > 400 and ≤ 800 mm, the execution forms are for the respective duct wall surfaces:

- for the respective duct wall surfaces: Cross-breakings: normal outward facing cross-breakings;
- grooves or rings: generally arranged transversely to the longitudinal axis of the duct, at intervals not exceeding 500 mm.

For ducts with a side > 800 mm, the previously mentioned types of implementation apply for the duct wall surfaces concerned, whereby surfaces with a surface area of more than than 1.5 m² are additionally stiffened by subdividing them in sub-areas of no more than 1 m². This additional stiffening in the form of strips, profiles, pipes or sheets are applied internally or externally.

2.1.6 Dimensions

The nominal sizes of the air ducts are given in mm and refer to the internal dimensions with a tolerance of ± 0 mm up to -4mm. The dimensions are standardised according to NEN-EN 1505 and can be selected as indicated in the table for standard dimensions.

	100	150	200	250	300	400	500	600	800	1000	1200
200		■	■								
250		■	■	■							
300		■	■	■	■						
400		■	■	■	■	■					
500		■	■	■	■	■	■				
600			■	■	■	■	■	■			
800				■	■	■	■	■	■		
1000					■	■	■	■	■	■	
1200						■	■	■	■	■	■
1400							■	■	■	■	■
1600								■	■	■	■
1800									■	■	■
2000										■	■

■ preferred area for aerial considerations

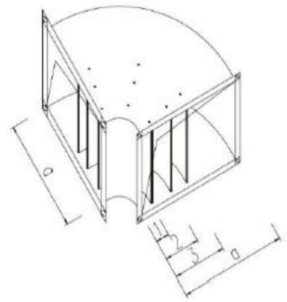
2.1.7 Bends

Symmetrical bends
As regards form, symmetrical bends are in principle designed as round bends, i.e. with an inner and an outer radius; the inner radius is 100 mm or greater (for floor or wall recesses and places where there is no room for an inner radius, an angled inner bend is used). For production reasons, angled inner bends can also be used. In order to limit the resistance in a bend, bends are provided with blades. Blades missing at:

- bends of 45° or smaller, provided they are not compound bends
- ducts with a width of 400 mm or less.

The position of the blades shall be determined according to the table below.

duct width a in mm	number of blades	position of the blades		
		1	2	3
> 400 ≤ 800	1	a/3		
> 800 ≤ 1600	2	a/4	a/2	
> 1600 ≤ 2000	3	a/8	a/3	a/2



Elongated bends
In the case of elongated bends, the smallest duct width determines the number of blades, in accordance with the table above. The ratio for the position of the blades of the largest duct width is then equal to the ratio for the blades of the smallest duct width.

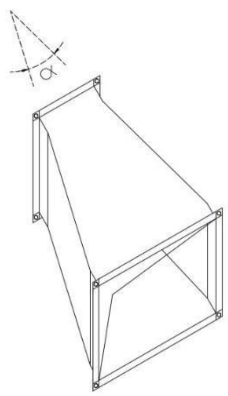
Blade design
The blades are made of single sheet metal. The sheet material is the same as the material from which the duct is made. The design and fixing are of sufficient strength, while the ends of the blades are stiffened.

2.1.8 Jumpers

For parallel shifting of channels, so-called jumpers are used. The jump made is equal to the height or width of the channel depending on the jump direction, taking into account equal passage. Picture see image in 6.2 Measurement methodology

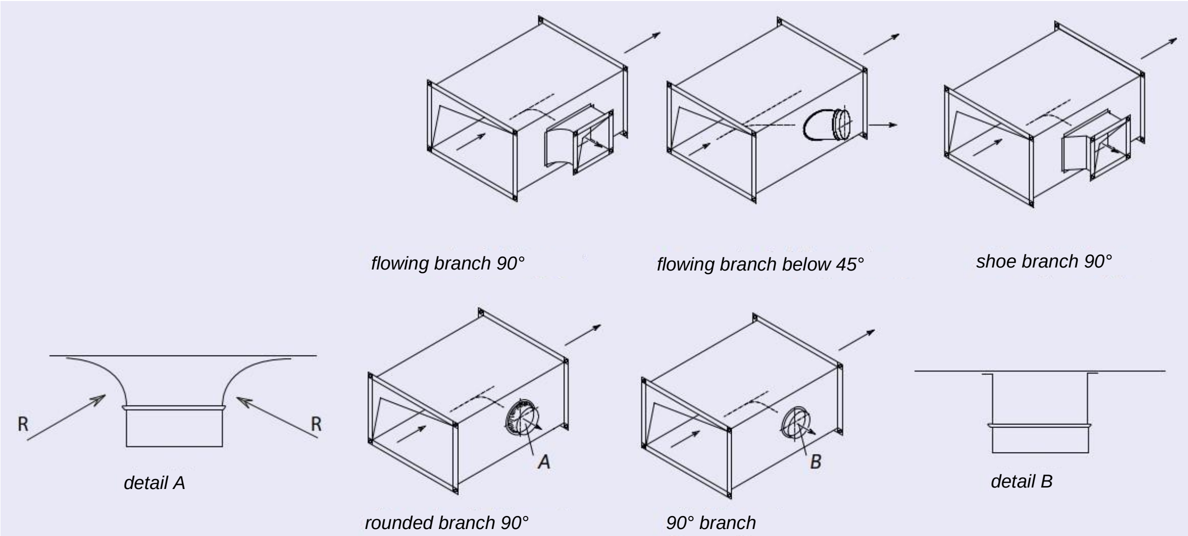
2.1.9 Adapters

Adapters are designed in such a way that the top angle α of the adapters may not exceed 60°.



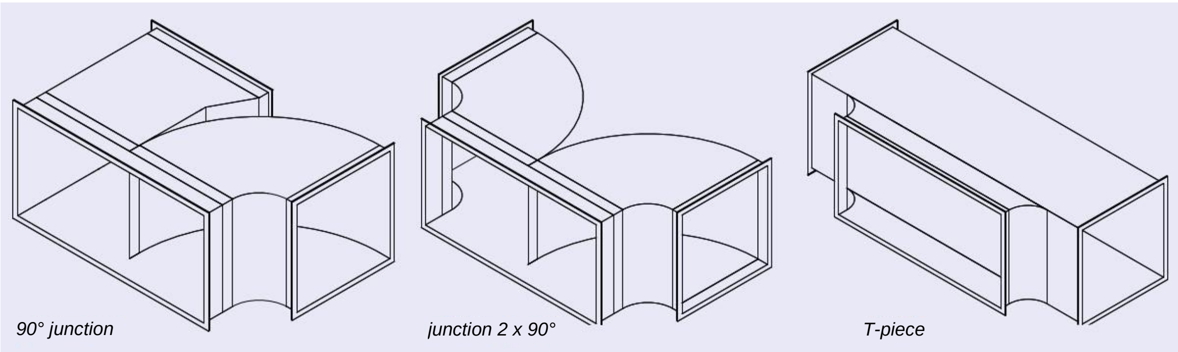
2.1.10 Branches

A branch can be created by means of an fitting in rectangular or round design. Aerodynamic aspects help determine the types, as shown in the following illustrations.



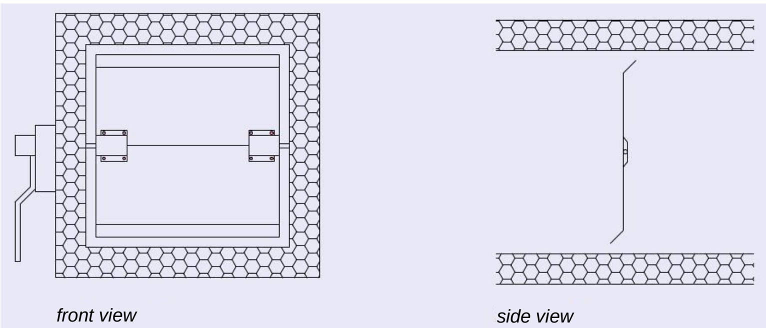
2.1.11 Splits

A split is a division of a main duct into two ongoing ducts.
Some examples of splits are:



2.1.12 Adjustment valves

Adjustment valves are manually adjustable and serve to regulate an installation. They are equipped with a sound locking device which also indicates the valve position. The damper blade, of the same material as the air duct, is executed in a single sheet with a thickness of at least 1.0 mm (executed according to the drawing below) up to a maximum blade width (B) of 300 mm and up to a maximum surface of 0.09 m². The edges of the damper blades are rounded and stiffened parallel to the axial direction.



2.1.13 Tolerances

The edges of the damper blades are rounded and stiffened parallel to the axial direction.
The tolerance for rectangular dimensions is + 0 to - 4 mm.
The maximum tolerance for angles is ± 2°.

2.2 Embedded air ducts in concrete floors made of galvanised steel

2.2.1 Sheet quality

For the manufacture of galvanised air ducts, sheet steel is used with anti-corrosion zinc-based coatings, applied using the Sendzimir process, in the qualities:

DX51D 150 MAC with a double-sided zinc coating of 150 g/m2 according to the triangulation test (average thickness of 10 microns per side). Sheet quality/zinc quality according to NEN-EN 10346, tolerances according to NEN-EN 10143.

DX51D Z 275 AC with a double-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 10 microns per side). Sheet quality/zinc quality in accordance with NEN-EN 10346, tolerances in accordance with EN 10143.

2.2.2 Sheet thickness

Rectangular galvanised air ducts are manufactured with a sheet thickness which depends on the largest duct side. Embedded ducts::

- dimensions: 170 x 70 and 170 x 80, are made of a plate thickness of 0.5 mm
- dimensions 300 x 80, 200 x 80, 220 x 80 and 250 x 80 from 0.6 mm sheet.

2.2.3 Cross-connections

In embedded rectangular ducts the cross-connections are executed as sliding connection, using a coupling piece or sleeve. This connection is secured by means of self-drilling parkers or, where possible, with spot welds and then finished off with tape, so that no water or cement can penetrate the air duct.

2.2.4 Longitudinal connections

Longitudinal joints are performed in a roll weld, standing seam or spot weld.

2.2.5 Stiffening

In a straight duct 300 x 80, reinforcements are provided in the centre of the duct with a maximum centre distance of 1m

2.2.7 Various designs of rectangular ducts

Straight duct
The straight ducts are supplied in standard lengths of 2.5 and 3 metres< depending on dimensions.

Bends
Bends are supplied in standard version as 90° or 45°, 30° bend and are flowing. Note: vertical bends can be executed at right angles

Coupling or sleeve
Couplings or sleeves are supplied as standard with a length of 80, 100, 125, 200, 300 or 600 mm, depending on the supplier. When the coupling is longer than 80 mm they are also called fitting pieces.

End caps
End caps are available in all the standard sizes listed above. Special end pieces are also available in EPP version.

T-pieces
T-pieces are supplied with an inner radius of at least 100 mm.

Angled side connection
A T-piece with right-angled inside corners can be made by making a cut in a straight duct the size of the side connection. This is then fitted to the straight duct using self-drilling parkers (with a maximum length of 13 mm), after which the connection is taped or sealed airtight using sealant. The side connection can also be installed at 45°.

Round connecting plugs or round flange sleeves
These are available in the internal dimensions Ø 80, Ø 100, Ø 125, Ø 150, Ø 160, Ø 180 and Ø 200 with a length that depends on the supplier and on the floor thickness. These connections can also be executed under 45°.

Rectangular saddle on round pipe (saddle piece)
The rectangular saddles can be supplied for a round pipe of Ø 180 up to Ø 500. Branching sizes are: 170 x 70, 170 x 80, 200 x 80, 220 x 80 and 250 x 80.

Loose corner
These are straight duct pieces with a cut-off corner on the side of the cover and provided with a circular connection mouth. The loose corner is available in a left, right or symmetrical version with a Ø 125, Ø 150, Ø 160 or Ø 180 connection.

Adapters
Adapters are executed in such a way that the top angle may not exceed 45°. These adapters can be made rectangular to round, or rectangular to rectangular.

2.2.8 Circular air ducts (for embedding in concrete floor)

See chapter 2.1.3 round ducts of galvanised steel.
In addition, these ducts are used for so-called pour-in pots. These are mainly used to make a transition from a horizontal duct (Ø 80 mm) in the floor to a vertical branch in the room, for example, to connect an extraction and/or supply valve in the room concerned.
The diameters that are used are:
ø100 and ø125 The branching diameter is ø80 mm. This branch can be single or double. Dimensions, thicknesses, material etc. are as mentioned in chapter 2.1.2.3.

2.2.9 Airtightness

Since these ducts are poured in, the joints and the duct itself must be leakproof for cement water. After being poured, the ducts are incorporated in the concrete floor and are considered to be airtight Class ATC-3.

2.2.10 Tolerances

The edges of the damper blades are rounded and stiffened parallel to the axial direction.
The tolerance for rectangular dimensions is + 0 to - 4 mm.
The maximum tolerance for angles is ± 2°.

2.3 Circular ducts made of galvanised steel

2.3.1 Sheet quality

For the manufacture of galvanised air ducts, sheet steel is used with anti-corrosion zinc-based coatings, applied using the Sendzimir process, in the qualities:

DX51D Z 275 MAC with a double-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 20 microns per side). Sheet quality/zinc quality according to NEN-EN 10346, tolerances according to NEN-EN 10143.

DX51D Z 275 AC with a double-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 10 microns per side). Sheet quality/zinc quality in accordance with NEN-EN 10346, tolerances in accordance with EN 10143.

2.3.2 Sheet thickness

Pipes

The galvanised air ducts are executed with a sheet thickness which is dependent on the diameter, as specified below. Based on the diameter the minimum sheet thickness for standard construction applies:

	63	mm	<	160	mm	=	0.4	mm
≥	160	mm	≤	250	mm	=	0.5	mm
>	250	mm	≤	500	mm	=	0.6	mm
>	500	mm	≤	800	mm	=	0.8	mm
>	800	mm	≤	1250	mm	=	1.0	mm

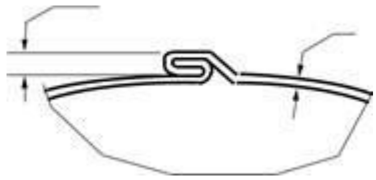
Fittings

The thickness of the sheet used for fittings depends on the diameter. Based on the diameter the minimum sheet thickness for standard construction applies:

	63	mm	≤	250	mm	=	0.5	mm
>	250	mm	≤	400	mm	=	0.6	mm
>	400	mm	≤	800	mm	=	0.7	mm
>	800	mm	≤	1250	mm	=	0.9	mm

2.3.3 Connection in pipes

The connection in the spiral wound belt is carried out in a flat flange, where sufficient stiffness and airtightness are obtained.



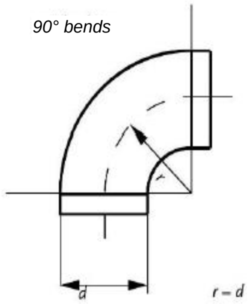
2.3.4 Connection in fittings

The connection of the seams in fittings is executed in such a way that sufficient stiffness and airtightness is obtained with plastically permanent sealing. This connection is made by welding or flanging mpression joints.

2.3.5 Length of pipes

Pipes are supplied as standard in lengths of 2000, 3000 or 6000 mm. For technical reasons, the length is not less than the diameter of the pipe with a minimum length of 300 mm.

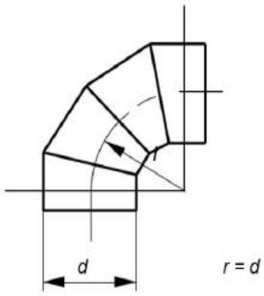
2.3.6 Diameters



The pipes are produced in standard diameters indicated in NEN-EN , being: 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250 mm.
Additional sizes are: 150, 180, 224, 300, 355, 450, 560, 710, 900, 1120 mm.

2.3.7 Bends

As regards form, bends are carried out as standard with a radius measured over the centre of the bend, equal to the diameter, except for diameters 63 and 80 where the radius is 100 mm. As standard Standard bends are made in angles of 15°, 30°, 45°, 60° and 90°, in pressed or segmentmented version. Segment bends ≥ 45° consist of a minimum of 3 segments.



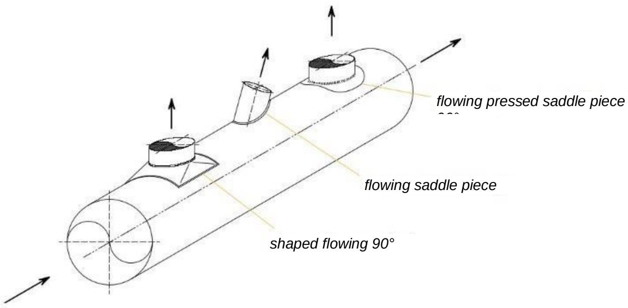
2.3.8 Adapters

Adapters can be both symmetrical and asymmetrical and have a top angle of minimum 15° and maximum 60°. For pressed adapters the maximum angle may be 90°. Symmetrical adapters are used as standard.

2.3.9 Branches

A branch can be accomplished by means of a:

- saddle piece, in combination with straight pipe;
- T-piece, as a complete fitting;
- cross-piece, as a complete fitting; and can be executed as standard in angles of 90° and 45°. Designs with an angle < 45° should be avoided for technical reasons.

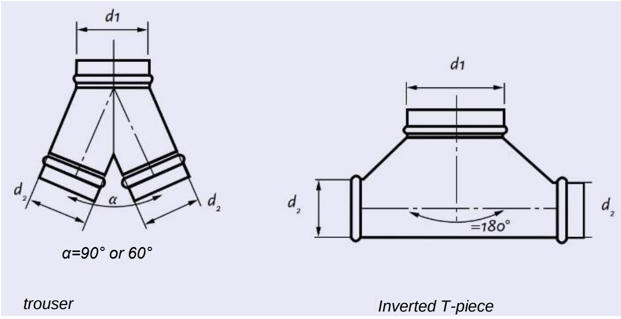


2.3.10 Splits

A split is a division of a main duct into two continuous ducts. It can be accomplished by means of a:

- trouser piece;
- inverted T-piece.

In the case of a trouser piece, the split can take place at an angle of α = 90° of 60°. When a T-piece is inverted, the split takes place at an angle of α = 180°.



2.3.11 Connectors

These find their standard application at:

- connectors between pipes; this fitting, made of the same material as the pipes and fitted with a bumper, creates an internal connection.
- connectors between fittings; this fitting, made of the same material as the pipes, is smooth with a bumper and establishes an external connection.

The insertion length of the fittings is attuned to NEN-EN 1506. For the overlap length the following minimum lengths have to be observed:

diameter	overlap length
63 mm ≤ 315 mm	≥ 25 mm
> 315 mm ≤ 800 mm	≥ 50 mm
> 800 mm	≥ 100 mm

2.3.12 Adjustment valves

Adjustment valves are either manually adjustable or motorised and serve to adjust an installation. Perforated valve blades should be avoided. See 3.2.2. Adjustment valve – circular for a detailed description.

2.3.13 End caps

The caps are made of the same material as the pipes.

2.3.14 Tolerances

The edges of the damper blades are rounded and stiffened parallel to the axial direction.
The tolerance for the diameters is shown in the following table.
The maximum tolerance for angles is ± 2°.

Standard sizes				Additional sizes			
Pipes		Fittings		Pipes		Fittings	
63	+0.5 / -0	63	-0.7 / -1.2	150	+0.6 / -0	150	-0.7 / -1.3
80	+0.5 / -0	80	-0.7 / -1.2	180	+0.7 / -0	180	-0.7 / -1.4
100	+0.5 / -0	100	-0.7 / -1.2	224	+0.8 / -0	224	-0.7 / -1.5
125	+0.5 / -0	125	-0.7 / -1.2	300	+0.9 / -0	300	-0.7 / -1.6
160	+0.6 / -0	160	-0.7 / -1.3	355	+1.0 / -0	355	-0.7 / -1.7
200	+0.7 / -0	200	-0.7 / -1.4	450	+1.1 / -0	450	-0.7 / -1.8
250	+0.8 / -0	250	-0.7 / -1.5	560	+1.2 / -0	560	-0.7 / -1.9
315	+0.9 / -0	315	-0.7 / -1.6	710	+1.5 / -0	710	-0.7 / -2.0
400	+1.0 / -0	400	-0.7 / -1.7	900	+2.0 / -0	900	-0.7 / -2.1
500	+1.1 / -0	500	-0.7 / -1.8	1120	+2.5 / -0	1120	-0.7 / -2.2
630	+1.2 / -0	630	-0.7 / -1.9				
800	+2.0 / -0	800	-0.7 / -2.0				
1000	+2.0 / -0	1000	-0.7 / -2.1				
1250	+2.5 / -0	1250	-0.7 / -2.2				

2.4 Oval ducts made of galvanised steel

2.4.1 Sheet quality

For the manufacture of galvanised air ducts, sheet steel is used with anti-corrosion zinc-based coatings, applied using the Sendzimir process, in the qualities:

DX51D Z 275 MAC with a double-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 20 microns per side). Sheet quality/zinc quality according to NEN-EN 10346, tolerances according to NEN-EN 10143.

DX51D Z 275 AC with a double-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 10 microns per side). Sheet quality/zinc quality in accordance with NEN-EN 10346, tolerances in accordance with EN 10143.

2.4.2 Sheet thickness

2.4.2.1 Sheet thickness of oval ducts

Galvanised air ducts are manufactured with a sheet thickness which depends on the largest duct side, as specified below. With this thickness the ducts are manufactured in such a way that they are sufficiently rigid to withstand deformation and troublesome vibrations. The minimum sheet thickness is based on the largest duct side:

	to	≤ 480 mm	≤ 0.60 mm
≤ 480 mm	to	≤ 855 mm	= 0.80 mm
≤ 855 mm	to	≤ 1120 mm	= 1.00 mm
≤ 1120 mm	to	≤ 2080 mm	= 1.20 mm

2.4.2.2 Sheet thickness of oval ducts

The following sheet thicknesses are used for the most common dimensions Starting from the largest duct side, the minimum sheet thickness is applied:
(This depends on the method of manufacture of the fitting).

	to	≤ 480 mm	= 0.60 mm
≤ 480 mm	to	≤ 855 mm	= 0.80 mm
≤ 855 mm	to	≤ 1120 mm	= 1.00 mm
≤ 1120 mm	to	≤ 2080 mm	= 1.20 mm

2.4.2.3 Tolerances

The maximum tolerances for the length of a straight duct is 0.005 x L
The tolerance for the oval ducts is +0 to +13 mm
The maximum tolerance for angles is 2°.
The tolerance for the oval fittings is -2 to -13 mm

2.4.3 Longitudinal connection in oval ducts

The connection in oval ducts depends on the manufacturer.
The following forms occur:

- Flat flange
- Weld seam

- Stud

The aim is to obtain sufficient stiffness and airtightness.

2.4.4 Connection in fittings

The connection of the seams in fittings is executed in such a way that sufficient stiffness and airtightness is obtained. This connection is made by welding or flanging or compression joints.

2.4.5 Length of oval ducts

Depending on the manufacturer, the ducts can, in principle, be made in any desired length. For technical reasons, the length is usually not less than 300 mm and no larger than 3000 mm.

2.4.6 Oval duct dimensions and equivalent diameters

The ducts are executed in standard dimensions as given in CEN draft nov 2004 /no 00156091. See table below. Equivalent diameters are in brackets.

	recommended dimensions										
	height in mm										
width in mm	**80**	**100**	**125**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**
	210 (130)										
	270 (150)	260 (170)	240(180)	230(190)							
	350(170)	340 (195)	325(210)	310(225)							
	455(190)	440(220)	430(245)	415(261)							
	520(200)	505(235)	485(260)	475(280)							
				550(300)	520(340)						
				625(315)	600(365)	570(395)					
				700(340)	675(385)	650(425)	615(450)				
				800(360)							
	770(415)	740(455)	710(485)	680(510)	655(530)						
				915(380)	885(440)	880(485)	825(525)	795(555)	770(580)	740(600)	710(610)
				1040(405)	1005(465)	975(520)	945(565)	920(600)	890(630)	860(650)	830(670)
					1150(495)	1120(554)	1100(600)	1065(645)	104t0(68o)	1010(705)	960(740)
					1310(525)	1280(585)	1250(640)	1220(685)	1195(730)	1165(760)	1135(790)
						1435(620)	1410(675)	1380(730)	1350(775)	1325(810)	1295(845)
						1630(655)	1600(720)	1575(775)	1555(825)	1515(870)	1485(910)
						1840(690)	1810(760)	1780(820)	1750(875)	1720(925)	1695(970)

	recommended dimensions										
	height in mm										
width in mm	**80**	**100**	**'25**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**
	240(140)	225(160)									
	310(160)	300(180)	280(195)	270(210)							
	360(170)	345(195)	335(215)	320(230)							
	400(180)	385(205)	370(225)	355(245)							
	430(185)	415(215)	400(235)	385(255)							
	440(188)	425(215)	410(240)	400(259)							
	480(194)	465(225)	450(250)	435(270)							
		545(240)	535(270)	520(290)							
				560(305)	530(345)						
				640(325)	610(365)	580(405)					
				720(340)	690(390)	665(430)	630(460)				
				860(370)	830(425)	805(470)	775(510)	750(543)	720(575)		
				88o(375)	850(430)	825(475)	790(515)	765(545)	735(570)	710(590)	680(605)
				940(385)	910(445)	805(470)	855(530)	830(575)	800(600)	770(605)	
				960(390)	930(450)	900(500)	875(540)	845(575)	820(605)	785(625)	760(645)
				1120(415)	1090(485)	1065(535)	1035(585)	1005(625)	980(660)	950(690)	920(715)
					1170(500)	1145(555)	1115(605)	1085(650)	1055(690)	1030(720)	1000(745)
					1240(485)	1225(575)	1195(625)	1165(670)	1140(715)	1110(745)	1080(775)
					1335(530)	1305(590)	1275(645)	1245(690)	1220(735)	1190(775)	1160(805)
						1385(605)	1355(660)	1325(715)	1300(760)	1270(800)	1240(830)
						1465(620)	1435(680)	1405(735)	1380(780)	1350(825)	1320(860)
						1600(650)	1565(715)	1535(775)	1510(820)	1480(865)	1455(910)
						1750(673)	1725(750)	1700(815)	1670(870)	1640(920)	1610(965)
						1905(700)	1880(750)	1860(815)	1825(870)	1800(920)	1770(965)
						1950(705)	1920(780)	1890(845)	1860(900)	1835(950)	1805(1000)
							2080(805)	2055(875)	2025(935)	1995(990)	1965(1040)

2.4.7 Bends

Horizontal

As regards form, bends are carried out as standard with a radius measured across the centre of the bend and equal to the width. Standard bends are made in angles of 15°, 30°, 45°, 60° and 90°, in a segmented version with a tolerance of ± 2°. Segment bends ≥45° consist of at least 3 segments.

Vertical

As regards form, bends are carried out as standard with a radius measured over the centre of the bend, equal to the diameter, except for diameters 63 and 80 where the radius is 100 mm. As standard Standard bends are made in angles of 15°, 30°, 45°, 60° and 90°, in a segmented version with a tolerance of ± 2°. Segment bends ≥45° consist of at least 3 segments.

2.4.8 Adapters (oval-oval / oval-circular / oval-rectangular)

Adapters can be either symmetrical or asymmetrical (both x-axis and y-axis) and have a top angle of minimum 15° and maximum 60°. Symmetrical adapters are used as standard.

2.4.9 Branches (circular or oval)

A branch can be established by means of a: saddle piece, in combination with straight pipe (round and oval);

- T-piece, as a complete fitting (circular or oval);
- cross-piece as a complete attachment; (circular or oval) and can be executed as standard in angles of 90° and 45°. Designs with an angle < 45° should be avoided for technical reasons. On the width side of the duct, a branch (circular) can also be made by means of a flat saddle piece. Both in 90 and in 45 degrees.

2.5 Rectangular aluminium ducts

2.5.1 Sheet quality

In general, aluminium rectangular ducts are made of sheet material in the quality Al 99.5 / EN AW 1050A.

2.5.2 Sheet thickness

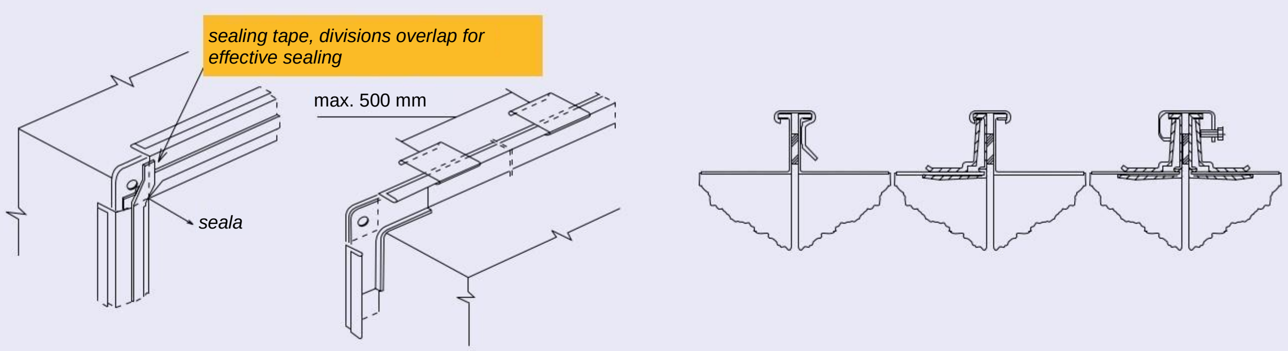
Aluminium air ducts are manufactured with a sheet thickness that depends on the largest duct side. For these thicknesses the ducts are manufactured in such a way that sufficient stiffness against deformations and troublesome vibrations is present. Starting from the largest duct side the minimum sheet thickness applies.

	to	≤ 500 mm	= 1.00 mm
≤ 500 mm			= 1.20 mm

2.5.3 Cross-connections

In rectangular air ducts, different types of cross-connections can be used. These are company specific, whereby the quality of the sheet, from which the connection profiles are formed, at least complies with that of the material from which the duct is manufactured. These cross-connections may (depending on the company) be rolled to the duct or fixed to the duct by means of push-throughs, parkers or pop rivets.
The cross-connections are connected with clips, sliding strips or clamps with a maximum centre-to-centre distance of 500 mm (see illustration). These fasteners are available in an ALU/RVS version.
A closed cell sealing tape is applied between the cross-connections in order to ensure airtightness; the minimum dimension B x H = 18 x 4 mm and all four corners must be fitted with stainless steel bolts and nuts, M 6 x 20 minimum. If sliding strips are used for the full circumference of the duct, the bolts and nuts at the corners can be omitted. Where necessary, an internal or external plastic sealant will be applied to ensure airtightness.

examples of various types of cross-connections



2.5.4 Longitudinal connections

Longitudinal connections between duct sections are made using a flange connection. Where necessary, plastic sealant is applied internally or externally to ensure airtightness.

2.5.5 Stiffening

See 2.1.5 Stiffening

2.5.6 Dimensions

See 2.1.6. Dimensions

2.5.7 Bends

See 2.1.7 Bends

2.5.8 Jumpers

See 2.1.8 Jumpers

2.5.9 Adapters

See 2.1.9 Adapters

2.5.10 Branches

See 2.1.10 Branches

2.5.11 Splits

See 2.1.11 Splits

2.5.12 Adjustment valves

See 2.1.12 Adjustment valves

2.5.13 Tolerances

See 2.1.13 Tolerances

2.6 Circular aluminium ducts

2.6.1 Sheet quality
For the manufacture of aluminium circular air ducts, sheet material in quality AL Mg3-(sheet material) EN and EN AW 5754 Mill Finish (strip material) in accordance with NEN-EN 573/485 is used.

2.6.2 Sheet thickness
Pipes
The aluminium air ducts are manufactured with a sheet thickness, that depends on the diameter, as specified below. Based on the diameter the minimum sheet thickness for standard construction applies:

	63	mm	≤ 200	mm	= 0.5	mm
>	200	mm	≤ 315	mm	= 0.7	mm
>	315	mm	≤ 1250	mm	= 1.0	mm

Fittings
The thickness of the sheet used for fittings depends on the diameter. Based on the diameter the minimum sheet thickness for standard construction applies:

	63	mm	≤ 200	mm	= 0.5	mm
>	200	mm	≤ 315	mm	= 0.7	mm
>	315	mm	≤ 1250	mm	= 1.0	mm

2.6.3 Longitudinal connections in pipes
See 2.3.3 Longitudinal connections in pipes

2.6.4 Connection in fittings
See 2.3.4 Connection in fittings

2.6.5 Length of pipes
See 2.3.5 Length of pipes

2.6.6 Diameters
See 2.3.6. Diameters

2.6.7 Bends
See 2.3.7 Bends

2.6.8 Adapters
See 2.3.8 Adapters

2.6.9 Branches
See 2.3.9. Branches

2.6.10 Splits
See 2.3.10 Splits

2.6.11 Connectors
See 2.3.11 Connectors

2.6.12 Adjustment valves
See 2.3.12 Adjustment valves

2.6.13 End caps
See 2.3.13 End caps

2.6.14 Tolerances
See 2.3.14 Tolerances

2.7 Rectangular ducts made of stainless steel

2.7.1 Sheet quality

For the manufacture of stainless steel rectangular air ducts, plates of grade X 5 CrNi-18-10-1.4301 according to NEN-EN 10088- 2 (AISI 304) or of grade X 5 CrNi-18-10-1.4404 according to NEN-EN 10088-2 (AISI 316) are applied.

2.7.2 Sheet thickness

Stainless steel air ducts are manufactured in a thickness depending on the largest duct size as specified below. For these thicknesses the ducts are manufactured in such a way that sufficient stiffness against deformations and troublesome vibrations is provided. The minimum sheet thickness is based on the largest duct side:
For technical reasons, thicknesses greater than 1.00 mm are avoided.

	to	≤ 1,500 mm	= 0.80 mm
≤ 1,500 mm			= 1.00 mm

2.7.3 Cross-connections

See 2.1.3 Stiffening

2.7.4 Longitudinal connections

See 2.1.4 Stiffening

2.7.5 Stiffening

See 2.1.5 Stiffening

2.7.6 Dimensions

See 2.1.6. Dimensions

2.7.7 Bends

See 2.1.7 Bends

2.7.8 Jumpers

See 2.1.8 Jumpers

2.7.9 Adapters

See 2.1.9 Adapters

2.7.10 Branches

See 2.1.10 Branches

2.7.11 Splits

See 2.1.11 Splits

2.7.12 Adjustment valves

See 2.1.12 Adjustment valves

2.7.13 Tolerances

See 2.1.13 Tolerances

2.8 Circular ducts made of stainless steel

2.8.1 Sheet quality
See 2.7.1. Sheet quality

2.8.2 Sheet thickness
See 2.7.2. Sheet thickness

2.8.3 Longitudinal connections in pipes
See 2.3.3 Longitudinal connections in pipes

2.8.4 Connection in fittings
See 2.3.4 Connection in fittings

2.8.5 Length of pipes
See 2.3.5 Length of pipes

2.8.6 Diameters
See 2.3.6. Diameters

2.8.7 Bends
See 2.3.7 Bends

2.8.8 Adapters
See 2.3.8 Adapters

2.8.9 Branches
See 2.3.9. Branches

2.8.10 Splits
See 2.3.10 Splits

2.8.11 Connectors
See 2.3.11 Connectors

2.8.12 Adjustment valves
See 2.3.12 Adjustment valves

2.8.13 End caps

See 2.3.13 End caps

2.8.14 Tolerances

See 2.3.14 Tolerances

2.9 Rectangular ducts made of hard plastic

This section has been dropped compared to the previous version.

2.10 Circular ducts made of hard plastic

This section has been dropped compared to the previous version

2.11 Embedded rectangular ducts made of hard plastic

This section has been dropped compared to the previous version

2.12 Rectangular ducts made of mineral wool with aluminium or polyester outer layer

2.12.1 Sheet quality

The mineral wool air ducts are made in the following design:

- glass wool minimum 70kg/m3
- glass wool with 100 micron aluminium foil outer layer, suitable for indoor installation, internally fitted with 20 micron aluminium.

The following specifications apply to the application of polyester:

- 450 gram/m2 glass fibre for an internal duct size smaller than 700 mm;
- 2 x 450 gram/m2 glass fibre for an internal duct size equal to or larger than 700 mm.

2.12.2 Sheet thickness

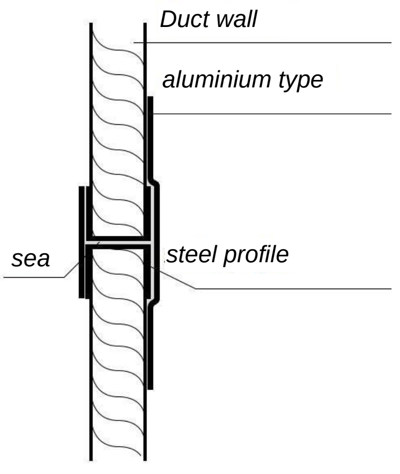
Mineral wool air ducts are manufactured with the following minimum sheet thicknesses:

- glass wool 22 mm with a tolerance of + 1 mm;
- glass wool 50 mm with a tolerance of + 1 mm;

2.12.3 Cross connections

Cross-connections of air ducts are performed between each other:

- DX51D Z 275 MAC with a double-sided zinc coating of 275 g/m2 according to the triangulation test (average thickness of 20 microns per side). Sheet quality/zinc quality according to NEN-EN 10346, tolerances according to NEN-EN 10143.
- DX51D ZMA120 AC with a double-sided zinc coating of 120 g/m2 according to the triangulation test (average thickness of 10 microns per side). Sheet quality/zinc quality in accordance with NEN-EN 10346, tolerances in accordance with EN 10143.



2.12.4 Longitudinal connections

Longitudinal connections are made as profiled seams and finished with an aluminium tape with a minimum width of 75 mm.

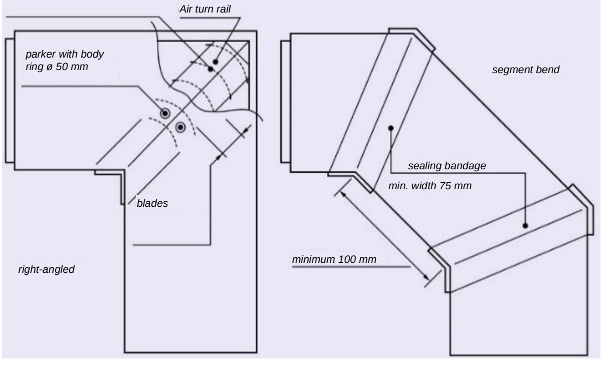
2.12.5 Stiffening

Air ducts are designed to be sufficiently stiff that no troublesome deformations occur. Based on the application of the recommended minimum panel thickness according to 2.12.2, duct surfaces with a width > 600 mm for glass wool are reinforced internally with stiffeners of galvanised material. These are attached to the duct area by means of parkers with washers. Number of stiffening profiles: 1 per 0.75 m2 of wall surface in the case of rock wool.

2.12.6 Bends

Bends are performed as:

- segment bends with an angle greater than 45°.
- right-angled bends are provided with blades or air turns;



2.12.7 Adapters
The adapters are designed in such a way that the top angle is always a maximum of 60°.

2.12.8 Branches
See 2.3.9. Branches

2.12.9 Adjustment valves
See 2.3.12 Adjustment valves

2.12.10 Tolerances
The nominal dimensions of the air ducts are given in mm and refer to the internal dimensions with a tolerance of ± 2 mm up to a side dimension of 1200 mm and ± 4 mm for a side dimension > 1200 mm. The dimensions are standardised according to the dimensions of rectangular metal ducts. The dimensions are standardised according to the dimensions of rectangular metal ducts.

2.13 Circular ducts of mineral wool

2.13.1 Material quality

The ducts are made of compressed glass wool with a reinforced foil on the inside and outside of the duct. The water vapour resistance > 140m2h Pa/mg

2.13.2 Material thickness

The average insulation thickness is 30mm.

2.13.3 Connections in duct

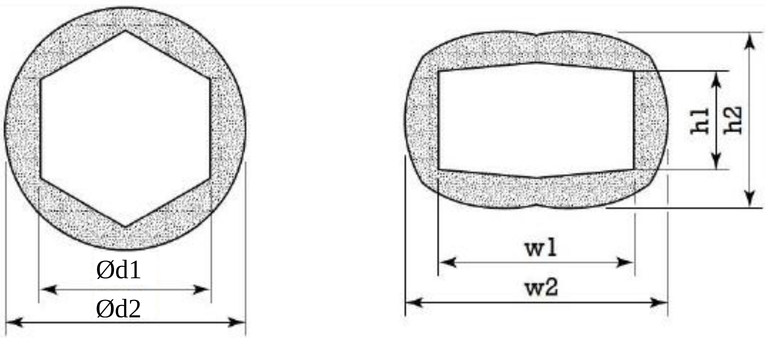
There are no longitudinal connections in the ducts. The manufacturing process results in a completely closed inner, middle and outer layer.

2.1.3.4 Connections in fittings

Fittings are manufactured from half-pressed layer parts, which are glued together. The outer and inner layer of the fitting are entirely covered with reinforced foil. This construction gives the fitting sufficient stiffness and strength.

2.13.5 Dimensions

The ducts are executed in standard diameters indicated in the table below.
It is possible to make the duct rectangular by using a suitable rectangular deformer. The dimensions and shape for this are in the table below.



Circular mounting

Ød1* mm	1 mm	Ød2* mm	m kg
125	235	195	0.64
160	2.35	230	0.86
200	235	270	1.06
250	2.35	320	1.34
315	235	385	1.66

Rectangular mounting

Ød1* mm	w1 mm	h1 mm	w2 mm	h2 mm
125	140	75	200	135
160	188	94	258	166
200	220	115	280	175
250	283	141	358	221
315	340	175	400	225

* Actual inner diameter = 10-20 mm larger than *Ød1*

2.13.6 Pipe length

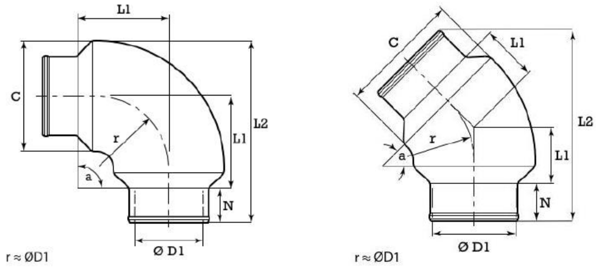
The pipes are manufactured with a standard length of 2350 mm. The duct can be easily shortened to the desired length.

2.13.7 Sealing of end pipes

A special end seal is used to cover the duct end (insulation) to make a proper airtight connection with the fitting. Made of plastic. For assembly see manufacturer's assembly guide.

2.13.8 Bends

As regards form, bends are manufactured as standard with a radius measured across the centre of the bend and equal to the diameter. (inside diameter) The bends are executed in an angle of 90° or 45° with a tolerance of ± 2°. The bends consist of 1 segment. For dimensions see table below.



Ød1 mm	C mm	L mm
125	192	157
160	233	192
200	267	232
250	317	282
315	382	347

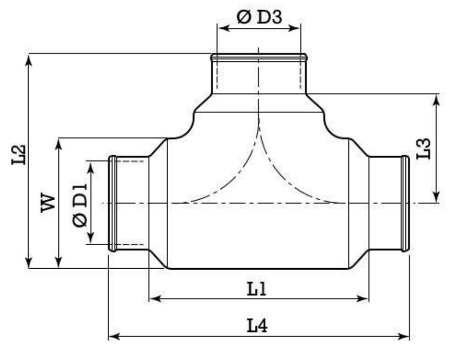
Ød1 mm	C mm	L mm
125	192	84
160	233	98
200	267	115
250	317	136
315	382	163

2.13.9 Adapters

Adapters are carried out symmetrically. Adapters are made to connect two different sizes of pipes.
The adapters are made of Sendzimir galvanized steel. The part of the adapter which does not fall within the duct must be insulated with a material which has the same properties as the base material of the pipes.

2.13.10 Branches / T-pieces

Branching/splitting is carried out with a preformed T-piece. The T-pieces are manufactured in the same way as the bends. Dimensions according to the table below.



Ød1 mm	Ød3 mm	L1 mm	L3 mm
125	125	314	157
160	160	384	192
200	125	464	184
200	200	464	232
250	250	564	282
315	125	694	242
315	200	694	280
315	315	694	347

2.13.11 Connectors

Connectors are made of Sendzimir galvanized steel, fitting into the pipes. There are two types of connectors;

- Connection between pipes
- Connecting the pipe with a standard spiral flanged pipe The dimensions and insertion length of

these connectors is fully matched to the pipe system.
The connectors are fixed with reinforced tape (tape according to supplier's recommendation) and go around the outer layer of the insulated duct.

2.13.12 Erosion resistance

In order to guarantee erosion resistance, the ducts are internally finished with a reinforced aluminium foil layer.

2.13.13 Fire resistance

The ducts are classified according to EN 13501-1:2007 - A2-S1, d0 (non-flammable)

2.13.14 System pressure/air density

The maximum permissible system pressure is 1000 Pa (internal overpressure).
The maximum negative pressure is -400 Pa.
The duct is tested according to EN1507:2006, airtightness class D

2.13.15 Operating temperature

The maximum operating temperature is -40°C - +60°C

2.13.16 Transition from mineral wool to steel

The transition to steel circular ducts is made by means of the appropriate transition piece, type adapter.

Adapter

2.13.17 Tolerances

Tolerances for circular ducts are +/- 1 mm

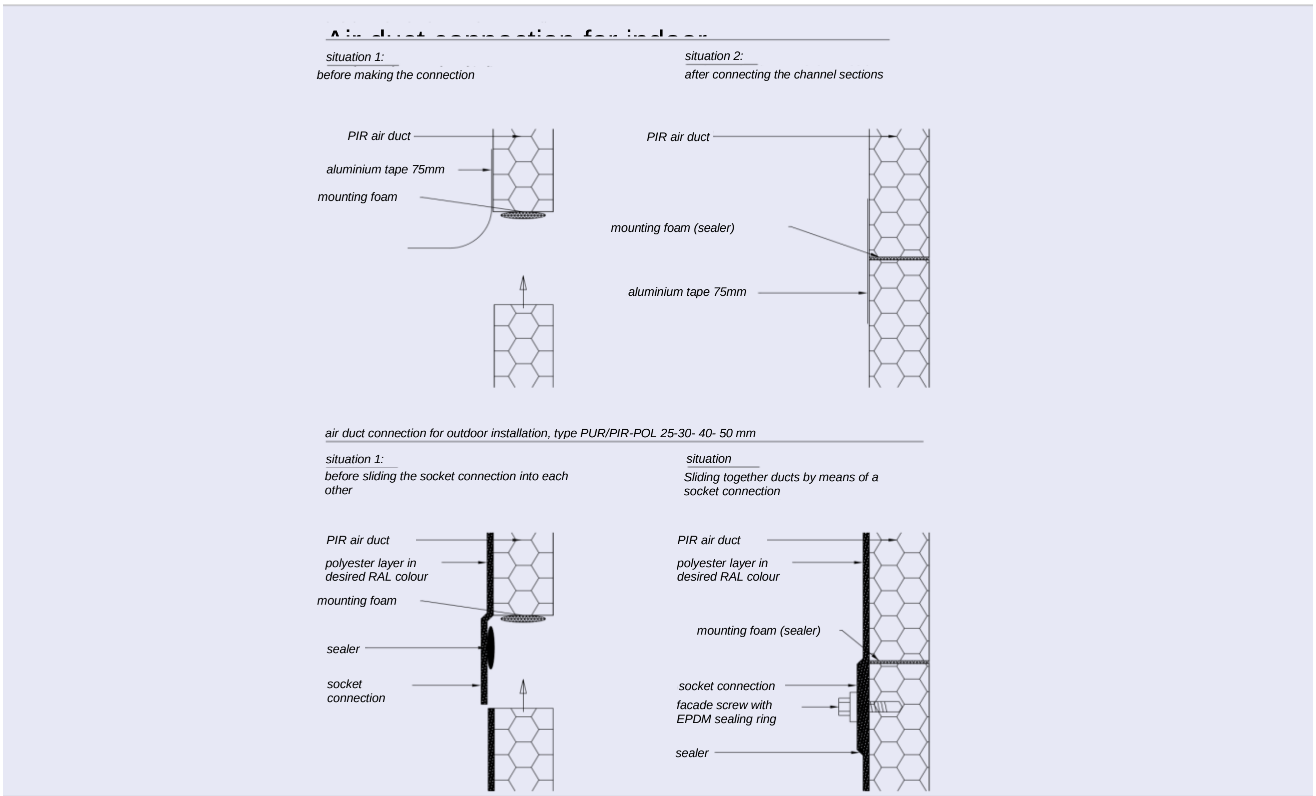
2.14.Rectangular hard foam ducts with aluminium outer layer

2.14.1 Sheet quality

The hard foam air ducts are manufactured from sheets with a minimum density of approximately 30 kg/m3. These sheets are coated on one or both sides with an aluminium foil with a minimum thickness of 60 microns.

2.14.2 Sheet thickness

Hard foam air ducts are manufactured in the minimum sheet thickness of 25 mm with a tolerance of +1.5 mm. At this thickness, the air ducts are manufactured in such a way that they are sufficiently rigid to withstand deformation.



2.14.3 Cross-connections

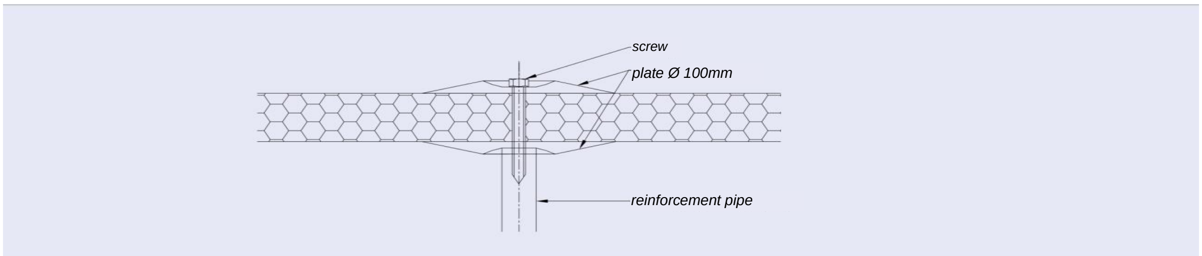
Cross-connections of hard foam air ducts are made in such a way that a sufficiently airtight connection is achieved. Here, we distinguish between connections for air ducts in an indoor installation and air ducts in an outdoor installation.

2.14.4 Longitudinal connections

The ducts are manufactured from a flat sheet, into which v-grooves are cut. These V-grooves are glued. The closing edges are cut at 45°, glued and finished with an aluminium tape with a minimum width of 75 mm and, if necessary, provided with e.g. connection clips. If the hard foam air ducts are provided with a polyester lining on the outside, aluminium tape with a minimum width of 60 mm may be used.

2.12.5 Stiffening

Air ducts are designed to be sufficiently stiff that no troublesome deformations occur. Assuming the application of the minimum sheet thickness in accordance with 2.1.2, duct surfaces are stiffened internally > 700 mm. Depending on the required specifications or application, the necessary plates and reinforcement pipes can be made of aluminium or galvanised steel.



2.14.6 Execution possibilities
Some of the execution possibilities of hard foam air ducts are:
- PUR foam with an aluminium casing outside and an aluminium casing inside, only suitable for indoor use;
- PIR foam with an aluminium casing outside and an aluminium casing inside, only suitable for indoor use;

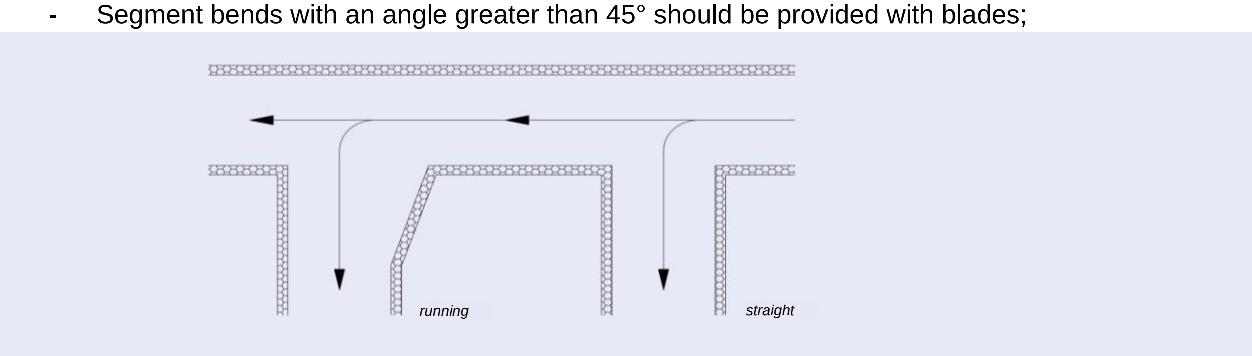
For the application of the polyester layer , assuming the application of the minimum sheet thickness according to 2.1.2 the following specifications apply:
- 450 gram/m² glass fibre for an internal duct size < 700 mm;
- 2x 450 gram/m² glass fibre for an internal duct size ≥ 700 mm.

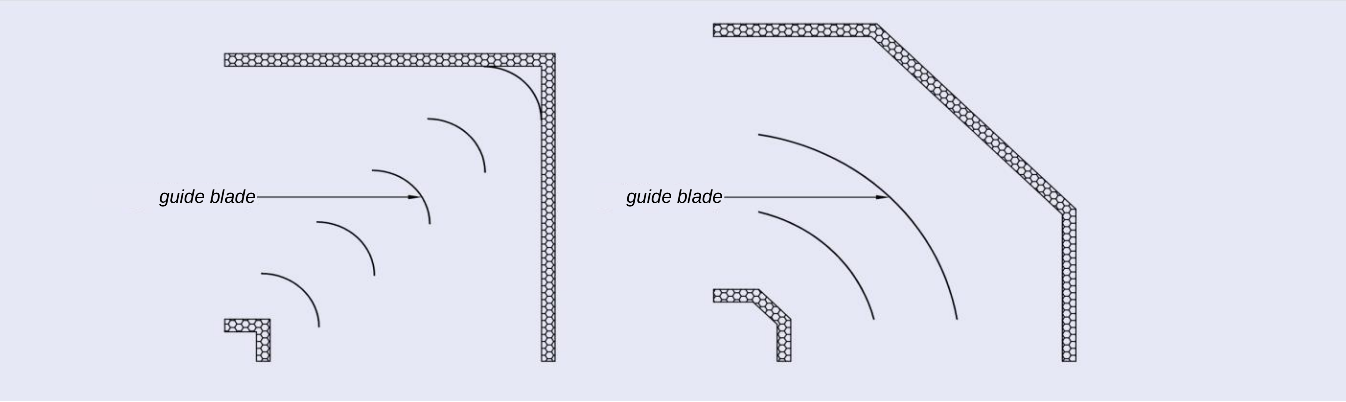
2.14.7 Dimensions
The nominal sizes of the air ducts are given in mm and refer to the internal (net) dimensions with a tolerance of ±2 mm up to and including a side of 1200 mm; ±4 mm with a side larger than 1200 mm. The dimensions are standardised according to the dimensions of rectangular metal ducts.

2.14.8 Visible work
If in an air technical installation a part of the air duct system has to be executed as 'visible work', this will be executed like the other duct work, unless it is mentioned otherwise in the specifications or the construction specifications. Additional measures within the framework of visible work are normally not part of the standard execution.

2.14.9 Bends
Bends are performed as follows:

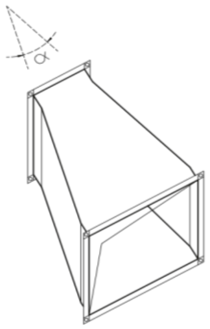
- Standard right angle bends are provided with blades or air turns;
- Segment bends with an angle greater than 45° should be provided with blades;





2.14.10 Adapters

Adapter pieces are designed so that the top angle α is no more than 60°..



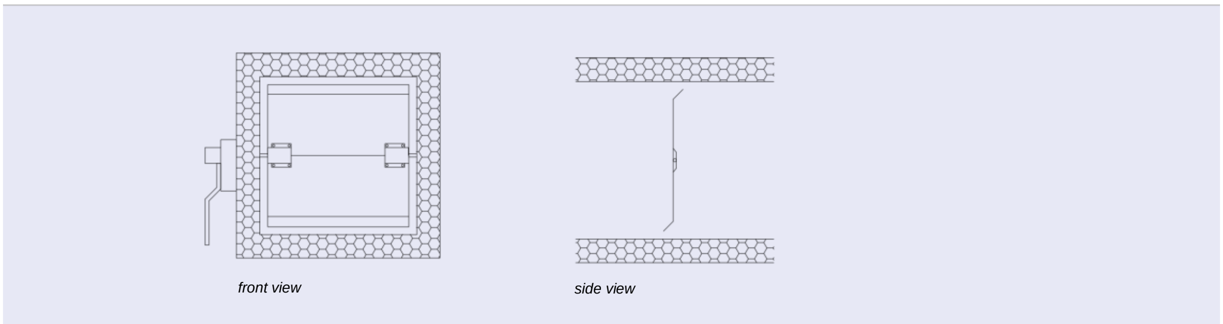
2.14.11 Branches

A branch (a split from a continuous main duct) can be realised by means of a straight or a flowing fitting and takes place at an angle of 90° maximum. Aerodynamic aspects also determine the type of execution.

2.14.12 Adjustment valves

Adjustment valves are manually adjustable and serve to regulate an installation. They are equipped with a sound locking device which also indicates the valve position. The damper blade, of the same material as the air duct, is executed in a single sheet with a thickness of at least 0.8 mm (executed according to the drawing below) up to a maximum blade width (B) of 300 mm and up to a maximum surface of 0.09 m². The edges of the damper blades are rounded and stiffened parallel to the axial direction.

2.14.13 Erosion resistance
In order to guarantee erosion resistance, the ducts are finished on the inside with an aluminium coating. The air velocity in the duct system may never exceed 12 m/s.



2.14.14 Permissible system pressure
The maximum permissible system pressure is 750 Pa. During a pressurisation test the air duct concerned is extruded once at a test pressure of 500 and once at a test pressure of 1000 Pascal.

2.14.15 Operating temperature
The maximum operating temperature for hard foam air ducts is 90°C.

2.14.16 Transition from plastic to metal
The transition from rectangular hard foam plastic ducts to metal air ducts can be achieved by following three principles. Which principle is applied depends on the desired transition. The choice of material for the transition depends on the steel air duct to be connected, for example galvanised steel, stainless steel or aluminium.

Principle 1: the end side is finished with a metal U-profile;

principle 2: the end side is provided with a metal air duct profile;

Principle 3: a circular mouth is placed at the end or in the duct wall.

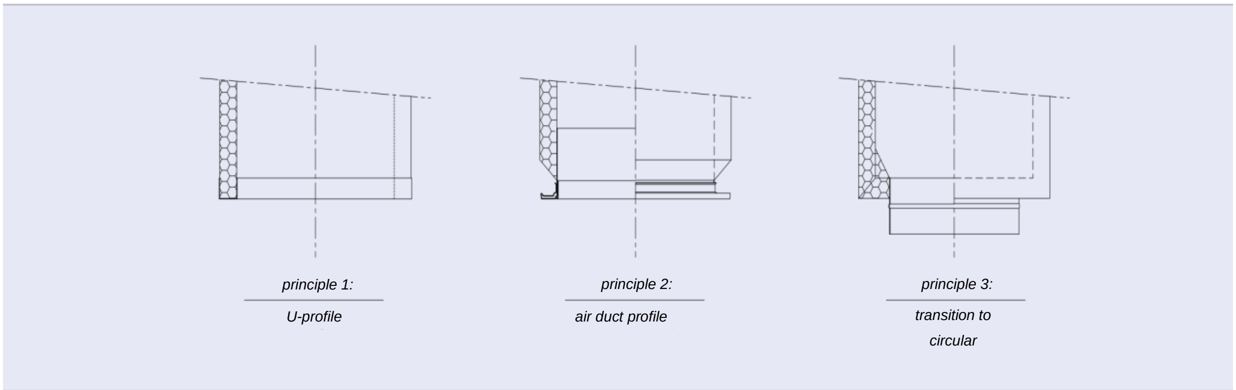
2.15. Rectangular hard foam ducts with polyester outer layer

2.15.1 Sheet quality
The hard foam air ducts are manufactured from sheets with a minimum density of approximately 30 kg/m3. These sheets are coated on one or both sides with an aluminium foil with a minimum thickness of 60 microns.

2.15.2 Sheet thickness
Hard foam air ducts are made in the minimum sheet thickness of 25 mm with a tolerance of
+1.5 mm. At this thickness, the air ducts are manufactured in such a way that they are sufficiently rigid to withstand deformation.

2.15.3 Cross-connections
Cross-connections of hard foam air ducts are made in such a way that a sufficiently airtight connection is achieved. Here, we distinguish between connections for air ducts in an indoor installation and air ducts in an

outdoor installation.

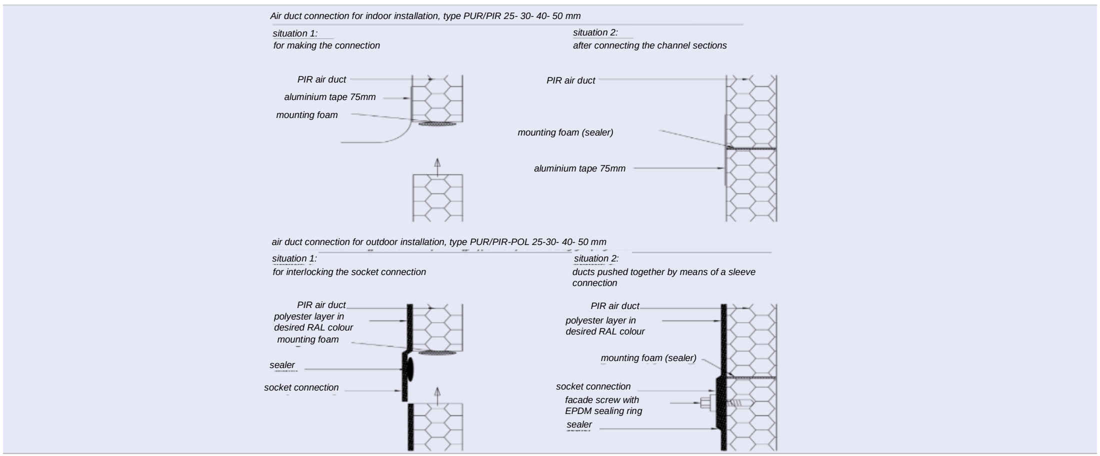


2.15.4 Longitudinal connections

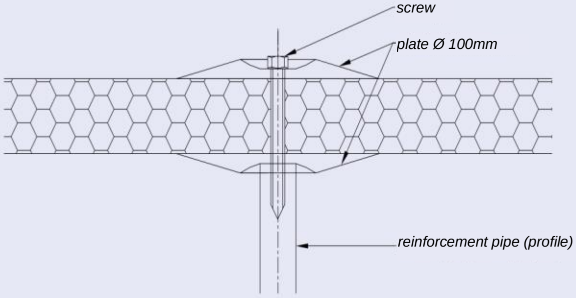
The ducts are manufactured from a flat sheet, into which v-grooves are cut. These V-grooves are glued. The closing edges are cut at 45°, glued and finished with an aluminium tape with a minimum width of 75 mm and, if necessary, provided with e.g. connection clips. If the hard foam air ducts are fitted with a polyester lining on the outside, aluminium tape with a minimum width of 60 mm may be used.

2.15.5 Stiffenings

Air ducts are designed to be sufficiently stiff that no troublesome deformations occur. Assuming the application of the minimum sheet thickness in accordance with 2.6.1.2, duct surfaces are stiffened internally > 700 mm.



Depending on the required specifications or application, the necessary plates and reinforcement pipes can be made of aluminium or galvanised steel.



2.15.6 Execution possibilities

Some of the execution possibilities of hard foam air ducts are:

- PUR foam with a glass fibre reinforced polyester outer layer and an aluminium casing inside, suitable for outdoor use;
- PIR foam with a glass fibre reinforced polyester outer layer and an aluminium casing inside, suitable for outdoor use.

For the application of the polyester layer, assuming the application of the minimum sheet thickness according to 2.1.2 the following specifications apply:

- 450 gram/m² glass fibre for an internal duct size < 700 mm;
- 2x 450 gram/m² glass fibre for an internal duct size ≥ 700 mm.

2.15.7 Dimensions

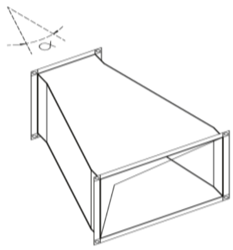
The nominal sizes of the air ducts are given in mm and refer to the internal (net) dimensions with a tolerance of ±2 mm up to and including a side of 1200 mm; ±4 mm with a side larger than 1200 mm. The dimensions are standardised according to the dimensions of rectangular metal ducts.

2.15.8 Visible work

If in an air technical installation a part of the air duct system has to be executed as 'visible work', this will be executed like the other duct work, unless it is mentioned otherwise in the specifications or the construction specifications. Additional measures within the framework of visible work are normally not part of the standard execution.

2.15.9 Bends

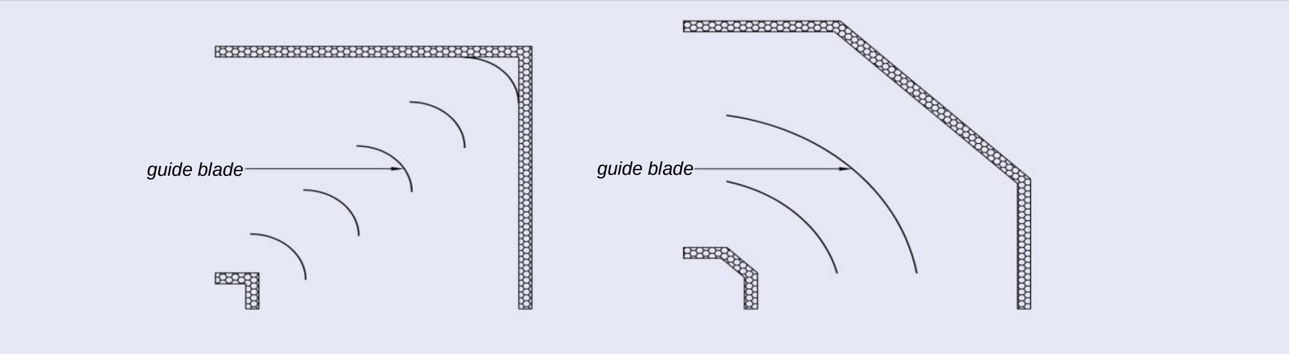
Bends are manufactured as follows:



- Standard right angle bends are provided with blades or air turns;
- Segment bends with an angle greater than 45° should be provided with blades;

2.15.10 Adapters

Adapter pieces are designed so that the top angle α is no more than 60°..

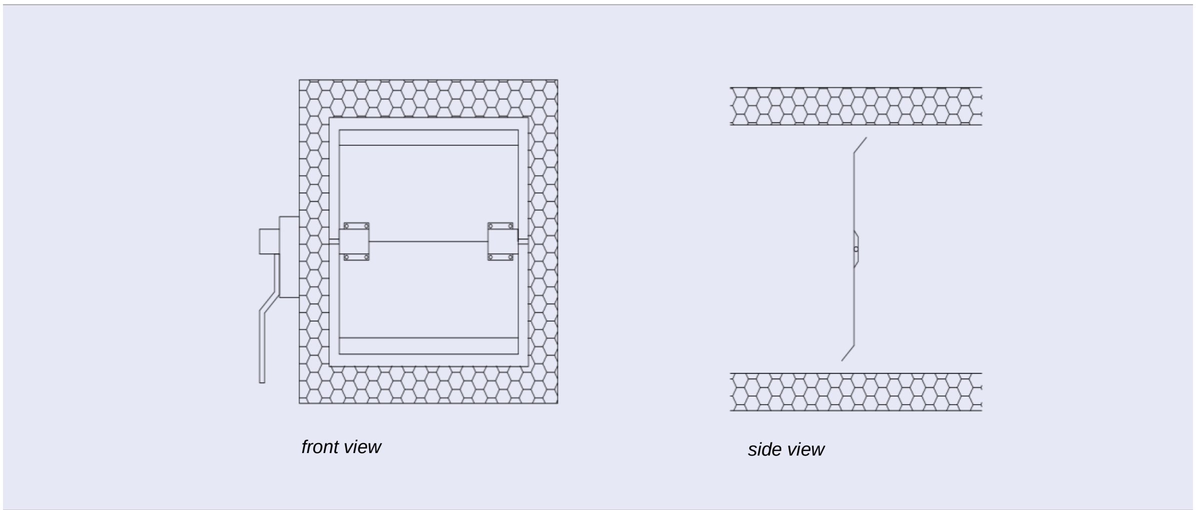


2.15.11 Branches

A branch (a split from a continuous main duct) can be realised by means of a straight or a flowing fitting and takes place at an angle of 90° maximum. Aerodynamic aspects also determine the type of execution.

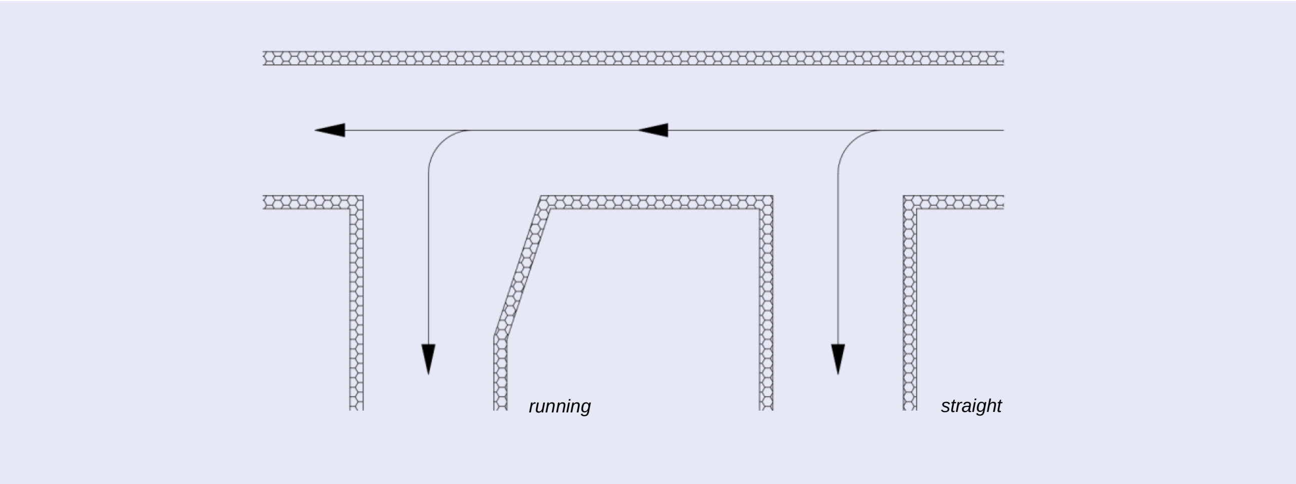
2.15.12 Adjustment valves

Adjustment valves are manually adjustable and serve to regulate an installation. They are provided with a apprpriate locking device which also indicates the valve position. The damper blade, of the same material as the air duct, is executed in a single sheet with a thickness of at least 0.8 mm (executed according to the drawing below) up to a maximum blade width (B) of 300 mm and up to a maximum surface of 0.09 m². The edges of the damper blades are rounded and stiffened parallel to the axial direction.



2.15.13 Erosion resistance

In order to guarantee erosion resistance, the ducts are finished on the inside with an aluminium coating. The air velocity in the duct system may never exceed 12 m/s.



2.15.14 Permissible system pressure

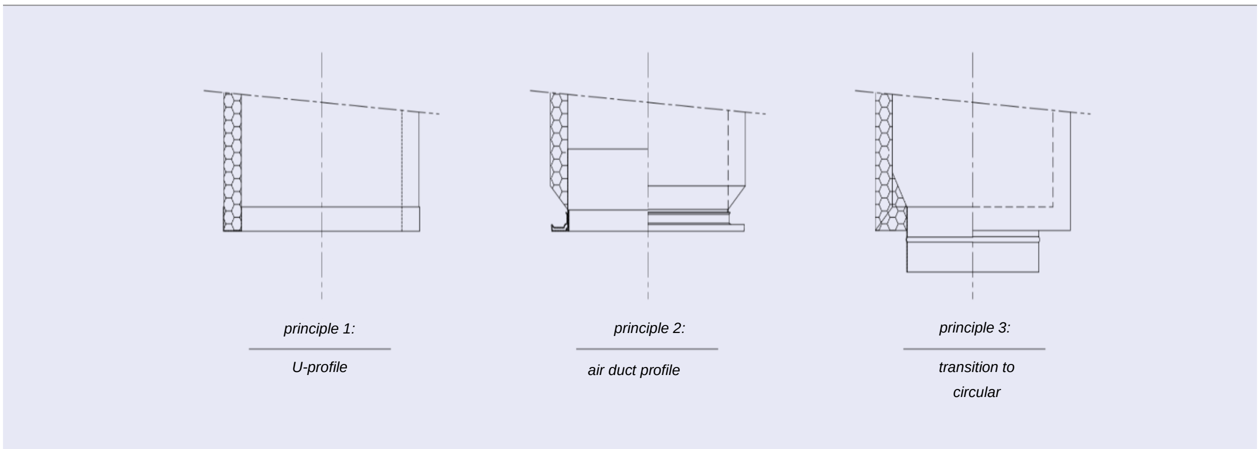
The maximum permissible system pressure is 750 Pa. During a pressurisation test the air duct concerned is extruded once at a test pressure of 500 and once at a test pressure of 1000 Pascal.

2.15.15 Operating temperature

The maximum operating temperature for hard foam air ducts is 90°C.

2.14.16 Transition from plastic to metal

The transition from rectangular hard foam plastic ducts to metal air ducts can be achieved by following three principles. Which principle is applied depends on the desired transition.
The choice of material for the transition depends on the steel air duct to be connected, for example galvanised steel, stainless steel or aluminium.

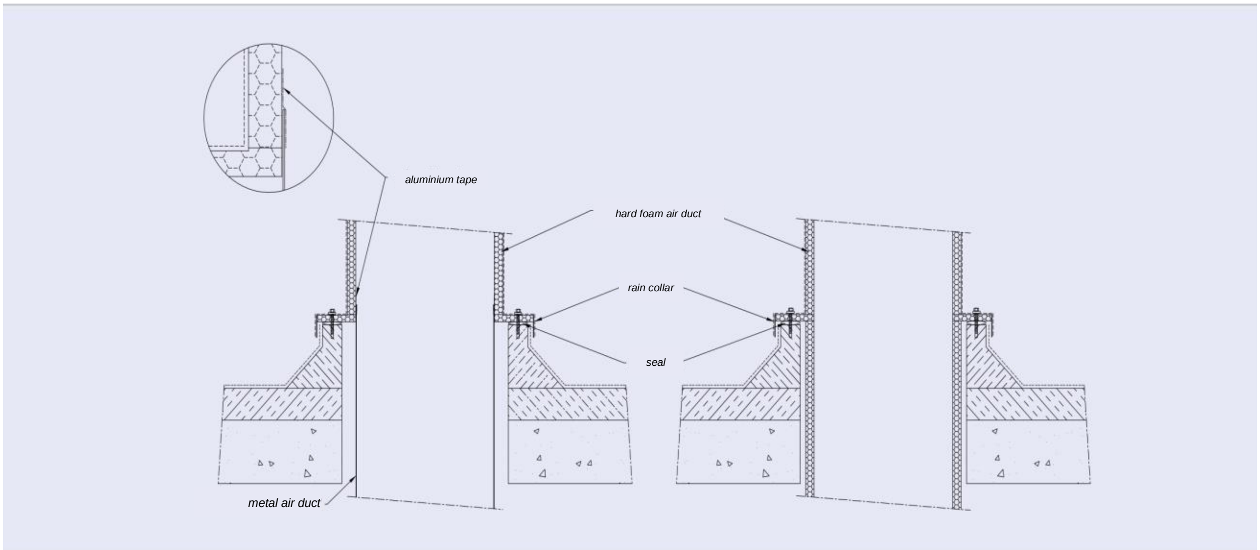


Principle 1: the end side is finished with a metal U-profile;
Principle 2: the end side is provided with a metal air duct profile;
Principle 3: a circular mouth is placed at the end or in the duct wall.

2.15.17 Connecting hard foam air ducts to roof transits

Plastic air ducts can connect to roof transits by means of two principles. Which principle is applied depends on the desired situation.

Principle 1: The metal air duct extends approximately 50 mm through the roof curb. This is where the transition from metal to plastic is made. The roof transit is then weatherproofed.



Principle 2: The plastic air duct is installed below the roof structure. In this process, the plastic air duct is inserted through the roof curb. The roof transit is then weatherproofed. If required, the transition from plastic to metal can be made according to the principles described in chapter 6.1.16.

2.1.16 Rectangular hard foam ducts with aluminium outer layer

2.16.1 Sheet quality

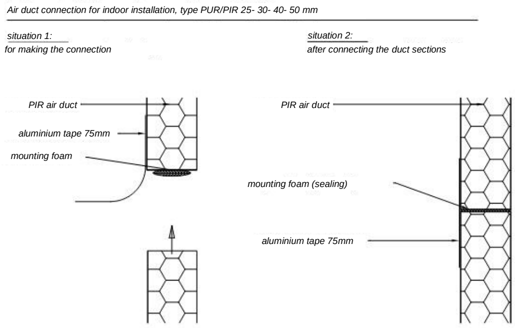
The hard foam air ducts are made of sheets with a minimum density of 30 kg/m3. These sheets are coated on one or both sides with an aluminium foil with a minimum thickness of 60 microns. Ducts a factory-applied aluminium layer suitable for outdoor use; Sandwich panels made of rigid polyurethane foam and covered with a 500 micron thick aluminium sheet (with relief structure) on the outside, and an 80 micron thick aluminium foil on the inside. The insulation material is foamed up with an expanding agent, for which water is used. Therefore it does not contain CFC, HCFC, HFC nor HC. Aluminium quality exterior layer: EN-AW 3105 in accordance with EN 573/3 The exterior layer is coated with a UV-resistant coating of the type: Super Windy , 17 µm thick. UV resistant according to NEN-EN 1396:2015 as RUV:3 The quality of the adhesion between the sheeting and the foam has a value of 1.2kg/cm2 according to NEN-EN 1607. The density of the PUR is 48kg/m3 with a tolerance of +/- 2kg/m3 in accordance with NEN-EN 1602 and has a light blue colour.

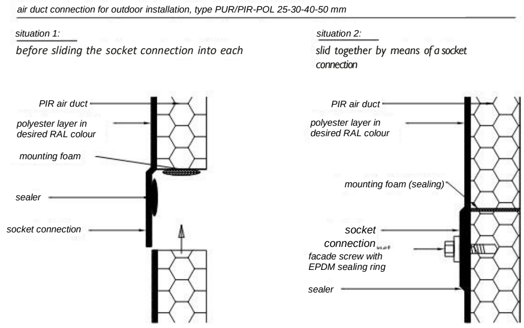
2.16.2 Sheet thickness

The hard foam air ducts are manufactured in the minimum panel thickness of 25* mm with a tolerance of +1.5 mm At this thickness, the air ducts are manufactured in such a way, that sufficient stiffness against deformation is present. Ducts with a factory-applied aluminium layer suitable for outdoor use; The standard thickness of the duct wall/plate is 30.5mm with a tolerance of +/- 0.5mm. The sheet is also available with a thickness of 50.5mm with a tolerance of +/- 0.5mm.

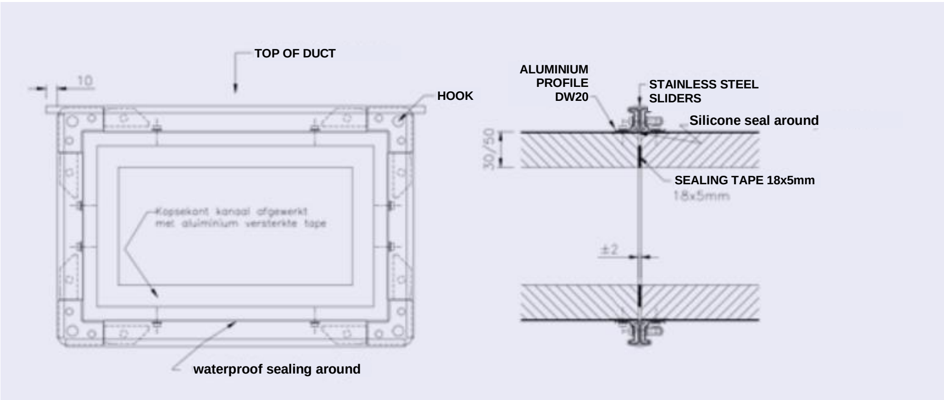
2.16.3 Cross-connections

Cross-connections of hard foam air ducts are made in such a way that a sufficiently airtight connection is achieved. Here, we distinguish between connections for air ducts in an indoor installation and air ducts in an outdoor installation

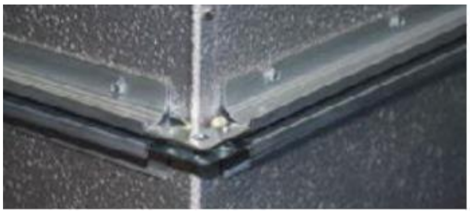




Cross-connections for hard foam ducts for outdoor installation with aluminium outer layer;



The transverse joints type DW profiles are made of aluminium, with aluminium corner pieces.. The profiles are attached to each other by means of stainless steel bolts and nuts. There is sealing tape between both profiles.



For extra watertightness, a stainless steel sliding strip is hammered onto the top of the DW profile. This should overlap the corner piece by at least 1.5 cm.

2.16.4 Longitudinal connections

The ducts are manufactured from a flat sheet, into which v-grooves are cut. These V-grooves are glued. The closing edges are cut at 45°, glued and finished with an aluminium tape with a minimum width of 75 mm and, if necessary, provided with e.g. connection clamps. If hard foam air ducts are fitted with a polyester lining on the outside, aluminium tape with a minimum width of 60 mm may be used. Longitudinal connections for hard foam ducts for outdoor installation with aluminium outer layer;

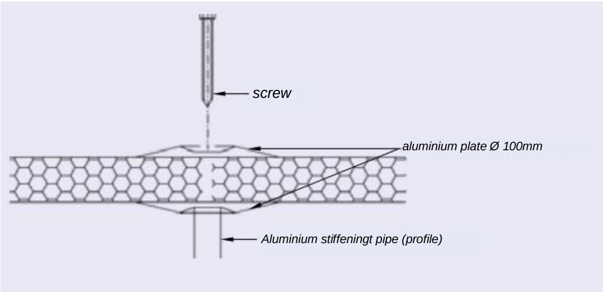
The ducts are manufactured from a flat sheet, in which V grooves are milled. These V grooves are glued. At the top of the duct, the closing side of the duct is provided with a so-called rain edge. In the rain edge there are stainless steel sheet screws which fix the rain edge on the vertical side of the duct. This prevents rainwater from entering the duct.

When installing, the rain edge must be at the top of the duct (see assembly instructions)

It is not allowed to have a partial connection in a duct plane.

2.16.5 Stiffening

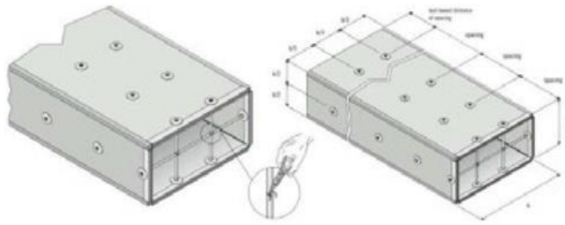
Air ducts are designed to be sufficiently stiff that no troublesome deformations occur. Assuming the application of the minimum sheet thickness in accordance with 2.6.1.2, duct surfaces are stiffened internally > 700 mm. Depending on the required specifications or application, the necessary sheets and stiffening pipes can be made of aluminium or galvanised steel.



Stiffening of exterior hard foam ducts with exterior aluminium layer;

Based on applications of the minimum thickness, duct surfaces are stiffened internally > 401 mm. The holes in the cladding for reinforcing rods are sealed at the factory with silicone sealant. Holes in the cladding for reinforcement rods are sealed from factory roads with silicone sealant. The number of reinforcement rods according to the table below.

Side w / h (mm)	Number of rods	Spacing (mm)
0 - 400	none	
401 - 600	1 rod	1000
601 - 800	1 rod	600
801 - 1400	2 rods	600
> 1401	after calculation	after calculation



2.16.6 Execution possibilities

Some of the execution possibilities of hard foam air ducts are;
- PUR foam with an aluminium layer outside and an aluminium layer inside, only suitable for indoor use;
- PUR foam with a glass fibre reinforced polyester outer layer and an aluminium layer inside, suitable for outdoor use;
- PIR foam with an aluminium layer outside and an aluminium layer inside, suitable for indoor use only;
- PIR foam with a fibreglass-reinforced polyester outer layer and an aluminium layer inside, suitable for outdoor use;
- PUR foam with an aluminium layer on the inside and a 500 um (factory made) aluminium layer on the outside.

For the application of the polyester layer, assuming the application of the minimum sheet thickness according to
2.6.1.2 the following specifications shall apply:
- 450 gram/m2 glass fleece for an internal duct size < 700 mm;
- 2x 450 gram/m2 glass fleece for an internal duct size ≥ 700 mm.

2.16.7 Dimensions

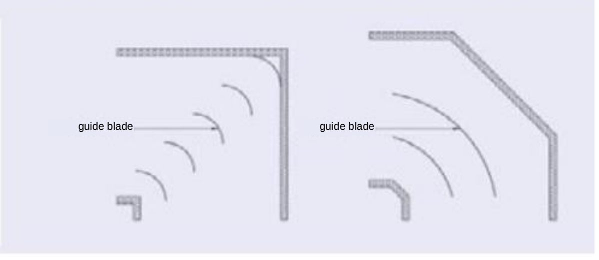
Nominal dimensions of air ducts are given in mm and refer to internal (net) dimensions with a tolerance of ±2 mm up to and including a side of 1200 mm and ±4 mm with a side larger than 1200 mm. The dimensions are standardised according to the dimensions of rectangular metal ducts.

2.16.8 Visible work

If in an air technical installation a part of the air duct system has to be executed as 'visible work', this will be executed like the other duct work, unless it is mentioned otherwise in the specifications or the construction specifications. Additional measures within the framework of visible work are normally not part of the standard execution. 2.6.3.9 Bends

Bends are performed as follows:

- segment bends with an angle greater than 45° should be provided with blades;
- right-angled bends are provided with blades or air turns;

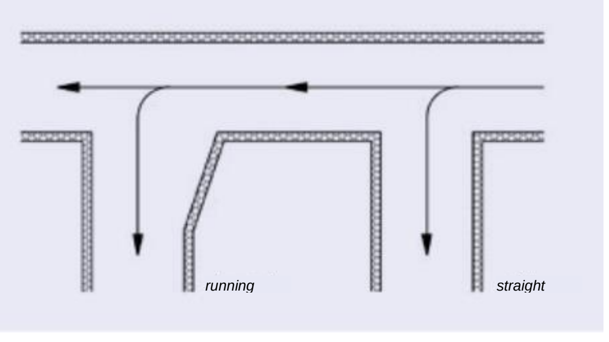


2.16.9 Adapters

Adapter pieces are designed so that the top angle α is no more than 60°.

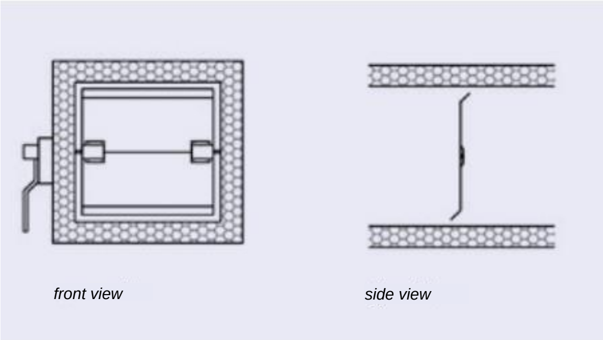
2.16.10 Branches

A branch (a split from a continuous main duct) can be realised by means of a straight or a flowing fitting and takes place at an angle of 90° maximum. Aerodynamic aspects also determine the type of execution.



2.16.11 Adjustment valves

Adjustment valves are manually adjustable and serve to regulate an installation. They are equipped with a sound locking device which also indicates the valve position. The valve blade is made of a single sheet with a thickness of at least 0.8 mm (executed according to the drawing below) up to a maximum blade width (B) of 300 mm and up to a maximum surface of 0.09 m2. The edges of the valve blades are rounded and stiffened parallel to the axial direction.

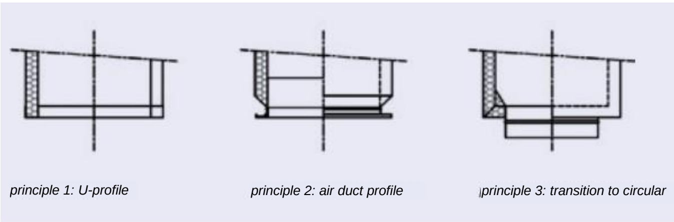


2.16.12 Erosion resistance
In order to guarantee erosion resistance, the ducts are finished on the inside with an aluminium coating. The air velocity in the duct system may never exceed 12 m/s.

2.16.13 Permissible system pressure
The maximum permissible system pressure is 750 Pa. During the pressurisation test, the duct in question is pressed once at a test pressure of 500 Pa and once at a test pressure of 1000 Pa.

2.16.14 Operating temperature
The maximum operating temperature for hard foam air ducts is 90°C.

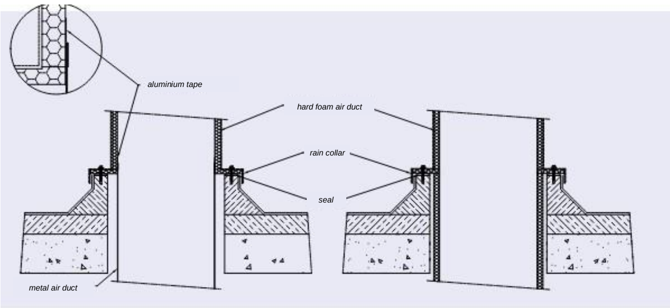
The maximum operating temperature of ducts fitted with aluminium layer on the outside for outdoor use have a maximum operating temperature of -30 to +65C 2.6.3.16 Transition from plastic to steel The transition from rectangular hard foam plastic air ducts to steel air ducts can be achieved using three principles. Which principle is applied depends on the desired transition. The choice of material for the transition depends on the steel air duct to which the duct should be connected, e.g. galvanized steel, stainless steel or aluminium. - principle 1: the end side is finished with a metal u-profile; principle 2: the end side is fitted with a metal air duct profile; principle 3: a circular mouth is placed at the end or in the duct wall.



(Note: all seams in the transition must be sealed watertight in external ducts.)

2.16.15 Transition from plastic to steel
Connecting hard foam air ducts to roof transits. Hard foam air ducts can be connected to roof transits by means of two principles. Which principle is used depends on the desired situation.

Principle 1: The metal air duct extends approximately 50 mm through the roof curb. This is where the transition from metal to plastic is made. The roof transit is then finished off in a weather-pfoof manner. Principle 2: The metal duct is installed under the roof curb. The hard foam air duct is inserted through the roof curb. The roof transit is then weatherproofed. If required, the hard foam/metal transition can be implemented in accordance with the principles outlined in section 2.6.3.16.



For ducts with an aluminium outer layer, a roof transit with air duct profile can also be chosen, on which the hard foam air duct directly connects. Of course, the duct (curb) must be finished weather-resistant.

2.17 Internal and external coating of air ducts

2.17.1 Purpose of coating

The purpose is to protect the ductwork. This may be because aggressive substances are present in the air, for example in swimming pools. The air drawn in may also contain components that increase corrosion. Coating can also take place with the aim to make internal cleaning easier. Examples are mineral wool or hard foam ducts used in the food industry.

2.17.2 Coating types

There are several types of coating with various applications and usage requirements. Common types are:

- water repellent bituminous coating;
- polyester coating;
- polyurethane coating;
- anticorrosive primer.

In addition to the purpose of the coating, the application is also determined by the nature of the air duct and the area of application of the duct. The nature of the duct can be distinguished into:

- rectangular mineral wool;
- rectangular hard foam;
- rectangular galvanized steel sheet;
- circular galvanized steel sheet.

types of coating	rectangular mineral wool	hard rectangular foam	galvanized rectangular	circular galvanized	scope
water repellent bitumen			x	x	air intake ducts outside
polyester					food industry
polyurethane				x	on corr. resis. surface
anticorrosive primer	X (flanges)	X (flanges)	x	x	in aggressive environment

2.17.3 Instructions for use

Application of the coating should be in accordance with the supplier's instructions.

2.18 Thermal insulation of rectangular and circular air ducts

2.18 Internal insulation of rectangular air ducts

Internal insulation can only be applied to rectangular ducts. In principle, circular ducts can only be insulated externally. However, in order to prevent contamination of the installation and other problems, it is strongly recommended that air ducts are only insulated externally. If the choice is made to insulate rectangular ducts internally, the following materials can be used:
glass- or rock-wool blankets with long fibres and finished with protective film against detachment of these fibres. Most common thicknesses 0.5" or 1" (13 or 26 mm);
vulcanised synthetic elastomers, mostly with self-adhesive film with a thickness of between 10 and 25 mm, depending on the application and manufacture.

2.18.2 Properties

Insulation blankets shall meet the following requirements:
Non-combustible, according to DIN 4102, class 2 and fire propagation, according to NEN-EN 13501, class 1;
Smoke number: ≤1 (smoke density negligible).

2.18.3 Processing of insulation blankets without self-adhesive foil

The insulation blankets are glued into the duct using contact adhesive. The entire duct surface is glued by means of a roller or spray adhesive. The contact adhesive can be applied at a temperature specified by the manufacturer/supplier. The duct wall must be dry, clean and free of grease to achieve good adhesion. For proper attachment, at least 2 adhesive pins, welding pins or split pins with cover sheet should be applied to the duct walls per m² of wall surface.

2.18.4 Finishing

The insulation should be finished at the ends of the duct using galvanised sheet metal profiles or plastic profiles. This is to prevent the insulation from coming off when duct sections are connected.

2.18.5 External insulation of rectangular and circular air ducts

External insulation can be divided into three sections:

- thermal insulation by means of glass wool or rock wool blankets (see 2.8.2.1);
- thermal insulation using synthetic rubber (elastomeric) foam (see 2.8.2.2);
- thermal insulation using glass wool or rock wool blankets finished with aluminium sheeting (see 2.8.2.3).

2.18.6 Thermal insulation by means of glass wool or rock wool blankets

This type of insulation is only used indoors. Rectangular and circular metal air ducts are, depending on the application, usually thermally insulated externally by means of solid glass wool or rock wool blankets with a thickness of 25 mm. These blankets are made of upright fibres, the so-called lamella mat, covered on one side with a foil of reinforced pure aluminium (thickness 0.02 mm). Lamella mats are available without and with a self-adhesive foil. For rectangular ducts, the insulation is installed against the insulation fill and finished on the suspension structure. The brace, which is used for circular ducts, is incorporated within the insulation. In the case of rectangular ducts, the suspension structure is outside the insulation. To this end, a hard pressed insulation filling of equal thickness is applied between the suspension structure and the duct wall and the seams are finished vapour-tight. It is also possible to lay the air ducts on MDF blocks with the same thickness as the insulation. The insulation must then be continued between the blocks (see 2.10.3.1). It is also possible to insulate the air ducts before installation. The insulation is then slightly pressed into the suspension bracket. The protective film around the insulation may not be torn.

2.18.7 Properties

Lamella mats shall meet the following requirements:

- non-combustible according to DIN 4102, class A2 and fire propagation according to NEN EN 13501, class 1;
- Smoke number: ≤ 1 (smoke density negligible).

2.18.8 Processing of insulation blankets without self-adhesive foil

The insulation blanket should be cut to the following length: For rectangular duct:

-L= 2x (duct width + 2x insulation thickness) + 2x (duct height + 2x
insulation thickness) + overlap.
For a circular duct:
-L = (duct diameter + 2x insulation thickness) x 3.14 + overlap.

2.18.9 Processing of insulation blankets with self-adhesive film

This insulation is used in poorly ventilated areas and installed as visible work because of the absence of adhesive pins in the case of rectangular
ducts up to a width of 1200 mm. The insulation should be cut to the following length:
For rectangular duct:
-L= 2x (duct width + 2x insulation thickness) + 2x (duct height + 2x insulation thickness) + overlap.
For a circular duct:
-L = (duct diameter + 2x insulation thickness) x 3.14 + overlap.

2.18.10 Adhering and finishing for rectangular ducts (without foil)

The lamella mats are glued to the duct using contact adhesive. The entire duct surface is glued by means of a roller or spray adhesive. The contact adhesive should be applied at temperatures as specified by the manufacturer/supplier, preferably above approx. 0°C. The duct wall must be clean, dry and free of grease to ensure a good adhesion between the insulation and the duct wall.
In order to prevent the insulation from coming off the duct wall during the drying process of the adhesive, at least 2 adhesive pins, welding pins or split pins with cover sheet must be fitted on the underside and side walls of the duct per m² of wall surface for horizontally installed air ducts wider than 600 mm. With vertically installed ducts, pins must be fitted on all walls wider than 600 mm. It is recommended that the insulation be placed exactly between the flange connections. If there is a risk of condensation on the flanges and it is necessary to insulate the flanges, a separate strip should be laid over the flange connection. The seams between the lamella mats are glued together using an aluminium all-weather tape, with a width of 75 mm and a minimum adhesive strength on steel of at least 9N/25 mm², and then smoothed.

2.18.11 Adhering and finishing of rectangular ducts (with foil)

After cutting the insulation to the correct size remove the protective sheet approx. 10 cm lengthways, fit the insulation in the correct position and press firmly over the entire surface (note that once the insulation is pressed it cannot be moved).
Then remove the remaining protective sheet in stages and press the insulation firmly against the duct wall over its entire surface. It is recommended to apply the insulation exactly between the flange connections. If there is a risk of condensation on the flanges and it is necessary to insulate the flanges, a separate strip should be laid over the flange connection. Ducts up to a width of 1200 mm do not need to be provided with adhesive pins, welding pins or splice pins. The ambient temperature during processing should be between +10° C and +50° C. The seams between the flanges should be covered with an aluminium "all weather" tape, with a width of 75 mm and a minimum adhesive strength on steel of at least 9N/25 mm², glued together and then smoothed.
with a width of 75 mm and a minimum adhesive strength on steel of at least 9N/25 mm², glued together and then smoothed.

2.18.12 Adhering and finishing in case of circular ducts

Spray adhesive and/or contact adhesive are not used for circular air ducts. The insulation is cut to the correct length and the overlap is prepared by cutting the insulation loose from the aluminium foil. The seams are then taped and smoothed using the tape mentioned in 2.8.2.1.5. In addition, a tension band of at least 10 mm wide should be tightened around the insulation every 600 mm.

2.18.13 Thermal insulation using synthetic rubber-based foam (elastomeric)

This type of insulation is only used inside buildings. Rectangular and circular metal ducts are insulated externally using the abovementioned insulating material if there are large temperature differences (e.g. external air ducts) or if the ducts are visible. This material is available in various thicknesses, depending on the manufacturer and the temperature differences that occur. This insulation material is available without and with a self-adhesive foil. In order to obtain the correct insulation, the suspension structures are kept outside the insulation for both rectangular and circular ducts. Furthermore, a separate strip of the same insulation thickness is always glued over the duct flanges.

2.18.14 Properties

The insulation shall meet the following minimum requirements:

- Non-combustible in accordance with DIN 4102, class A2 and fire propagation in accordance with NEN-EN 13501, class 1;
- Smoke number: ≤ 1 (smoke density negligible);
- practical fire behaviour: self-extinguishing, non-dropping and non-flammable.

2.18.15 Processing

The insulation should be cut to the following length: For rectangular duct:
All sides are cut to size of the side + 1x insulation thickness.
For a circular duct:
L= (duct diameter + 2x insulation thickness) x 3.14.

2.18.16 Adhering and finishing

For both rectangular and circular ducts the insulation boards are glued over the entire surface with an adhesive provided by the insulation supplier. All bumpers should be pressed properly and therefore also glued properly. This also applies to the use of boards with a self-adhesive layer. The surfaces to be glued should be free of dust and grease. This form of insulation does not require any further finishing with tapes or adhesive pins.

2.18.17 Thermal insulation using glass wool or rock wool blankets, finished with aluminium sheeting

2.18.18 General

For the application of the mineral wool blanket, see Chapter 2.8.2.1.

2.18.19 Installation of aluminium sheeting

Externally insulated ducts in the open air can be finished with (stuco) aluminium sheeting. In coastal areas the seawater-resistant quality (AlMg 3/ ENAW 5754) is recommended. After the metal air ducts have been installed on the roof or along a façade in the open air, the external insulation is applied with the required material and thickness.

Then the aluminium sheet is applied. The thickness of the aluminium sheet is at least 0.8 mm. The sheet is applied by overlapping the neighbouring sheets. Plating is done by overlapping adjacent boards. These sheets are fitted with so-called grooves that are grooved into the board about 20-25 mm from the sheet end. These grooves are placed on top of each other and attached to each other with at least 13 x 3 mm stainless steel sheet screws (8 pcs/m) with screw thread up to the head.
It is also possible to use rivets (aluminium/aluminium version) instead of sheet screws. However, installation and dismantling is more labour-intensive when using blind rivets. The sheets are installed tightly around the insulation, overlapping and draining in such a way that raining in and leakage are not possible. For this purpose, all seam connections in the sheet metal are sealed with transparent silicone sealant during or after the installation of the aluminium sheeting.

In order to obtain a tight fit (especially in the case of larger ducts), it is possible to attach aluminium reinforcing strips to the duct during the insulation process. The aluminium sheeting can then be fixed to these strips. Care should be taken not to fasten the aluminium strips directly onto the steel. This is due to the risk of electrolytic voltage corrosion. A solution for this is to apply sealant, paint or a tape between the duct and the reinforcement strip.

2.19 Fire resistant insulation and sheeting of metal air ducts

2.19.1 Fire resistant insulation of circular air ducts

If fire resistance is required for the air duct, it is recommended to use systems tested according to EN 1366.1 Circular ducts can be insulated against fire using mineral wool mesh blankets. There are two products on the market which satisfy the requirements for fire resistance:

- non-combustible rock wool mesh blanket;
- lightweight mineral wool mesh blanket.

These are products for fire separating systems ranging from 15 to 120 minutes, depending on density and/or insulation thickness. An increase in the weight of the duct in relation to the duct suspension must be taken into account. The weight per m2 of sheet surface is a measure for this.
For a 60 minutes fire resistant system the following products are available:

type of product	fire resistance	Isolated thickness	weight	maximum duct dimension
rock wool mesh blanket	60 minutes	90 mm	9 kg/m²	1000 mm
lightweight mineral wool mesh blanket	60 minutes	75 mm	4 kg/m²	1000 mm

2.19.2 Fire resistant insulation of rectangular air ducts

If the air duct has to meet fire resistance requirements, it is recommended that systems tested to EN 1366-1 are used. Rectangular ducts can be insulated with mineral wool or fibresilicate sheets.

2.19.3 Mineral wool insulation sheets

There are two mineral wool products on the market for the fireproof insulation of rectangular ducts:

- non-combustible rock wool sheet;
- lightweight mineral wool sheet.

The mineral wool sheets are fitted directly to the air duct in accordance with the supplier's instructions. These sheets are usually fixed using weld pins or screw spacers. Sometimes it is also necessary to fix the sheets to each other using a special type of glue.
The products can be used for fire separating systems ranging from 15 to 120 minutes, depending on density, insulation thickness and/or duct orientation. An increase in the weight of the duct in relation to the duct suspension must be taken into account. The weight per m2 of sheet surface is a measure for this.
For a 60 minute fire resistant system, the following options are available in mineral wool boards:

type of product	fire resistance	duct orientation	insulation thickness	weight	maximum duct dimension
rock wool insulation sheet	60 minutes	vertical or horizontal	60 mm	13 kg/m²	w x h = 1250 x 1000 mm
lightweight mineral wool board	60 minutes	horizontal	60 mm	4 kg/m²	w x h = 1250 x 1000 mm
lightweight mineral wool board	60 minutes	vertical	80 mm	5.3 kg/m²	w x h = 1250 x 1000 mm

2.19.4 Insulating sheets of fibresilicate

- non-combustible sheets of fibresilicate.

Asbestos-free sheets made of fibres, Portland cement and aggregates should be installed according to manufacturer's instructions.

fire resistance	thickness duct sheeting (around connecting flange)
30 minutes	25 mm
60 minutes	35 mm
90 minutes	40 mm
120 minutes	52 mm

2.19.5 Suspension of fire resistant insulated air ducts.

The air ducts should in principle be suspended as in the standard test method. The data below is taken from publication SBR/ISSO 809.14.

Table 26 - Details of the studs

diameter	surface area	maximum load
for 30 and 60 minutes fire resistance (max. 9 N/mm^2)		
M8	31.9 mm^2	287 N (28.7 kg)
M10	50.9 mm^2	458 N (45.8 kg)
M12	74.3 mm^2	500 N (50.0 kg)
for 90 and 120 minutes fire resistance (max. 6 N/mm^2)		
M8	31.9 mm^2	191 N (19.1 kg)
M10	50.9 mm^2	305 N (30.5 kg)
M12	74.3 mm^2	445 N (44.5 kg)

As a rule of thumb, we recommend this:
Maximum distance between two suspension points (c.t.c.): 1.5 with the first suspension point at maximum 0.5 m from the fire damper. Weight per suspension point maximum 50 kg.
Suspensions must be supported by means of a mounting rail and must be suspended by means of threaded rods at least M6 in metal plugs. This applies to both rectangular and circular ducts.

2.19.6 Table dimensions threaded rods - rectangular air duct

Fire resistance 60 minutes

Support 1000 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 6	M 6	M 6						
150		M 6	M 6	M 6	M 6					
200		M 6	M 6	M 6	M 6	M 6				
250			M 6	M 6	M 6	M 8	M 8			
300				M 6	M 6	M 8	M 8	M 8		
400					M 6	M 8	M 8	M 8	M 8	
500						M 8	M 8	M 8	M 10	M 10
600							M 8	M 8	M 10	M 10
800								M 10	M 10	M 12
1000									M 10	M 12

Support 1250 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 6	M 6	M 6						
150		M 6	M 6	M 6	M 6					
200		M 6	M 6	M 6	M 8	M 8				
250			M 6	M 6	M 8	M 8	M 8			
300				M 8	M 8	M 8	M 8	M 8		
400					M 8	M 8	M 8	M 10	M 10	
500						M 8	M 8	M 10	M 10	M 12
600							M 10	M 10	M 10	M 12
800								M 10	M 12	M 12
1000									M 10	M 12

Support 1500 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 6	M 6	M 6						
150		M 6	M 6	M 6	M 8					
200		M 6	M 6	M 8	M 8	M 8				
250			M 6	M 8	M 8	M 8	M 8			
300				M 8	M 8	M 8	M 8	M 10		
400					M 8	M 8	M 10	M 10	M 12	
500						M 8	M 10	M 10	M 12	M 12
600							M 10	M 12	M 12	M 12
800								M 12	M 12	M 14
1000									M 12	M 14

Fire resistance 90 minutes

Support 1000 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 8	M 8	M 8						
150		M 8	M 8	M 8	M 8					
200		M 8	M 8	M 8	M 8	M 10				
250			M 8	M 8	M 8	M 10	M 12			
300				M 8	M 10	M 10	M 12	M 10		
400					M 10	M 10	M 12	M 10	M 12	
500						M 12	M 12	M 12	M 14	M 14
600							M 14	M 12	M 14	M 14
800								M 12	M 14	M 14
1000									M 14	M 14

Support 1250 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 8	M 8	M 8						
150		M 8	M 8	M 8	M 10					
200		M 8	M 8	M 8	M 10	M 10				
250			M 8	M 10	M 10	M 10	M 12			
300				M 10	M 10	M 12	M 12	M 12		
400					M 12	M 12	M 12	M 14	M 14	
500						M 12	M 12	M 14	M 14	M 14
600							M 14	M 14	M 14	M 14
800								M 14	M 14	M 14
1000									M 14	M 16

Support 1500 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 8	M 8	M 8						
150		M 8	M 8	M 10	M 10					
200		M 8	M 8	M 10	M 10	M 12				
250			M 10	M 10	M 12	M 12	M 12			
300				M 10	M 12	M 12	M 12	M 14		
400					M 12	M 12	M 14	M 14	M 14	
500						M 12	M 14	M 14	M 14	M 16
600							M 14	M 14	M 14	M 16
800								M 14	M 16	M 16
1000									M 16	M 16

Fire resistance 120 minutes

Support 1000 mm (c.t.c.)

H	B	200	250	300	400		500	600	800	1000	1200
100		M 8	M 8	M 8							
150		M 8	M 8	M 8	M 8						
200		M 8	M 8	M 8	M 8		M 10				
250			M 8	M 8	M 10		M 10	M 10			
300				M 8	M 10		M 10	M 12	M 12		
400					M 10		M 10	M 12	M 12	M 12	
500							M 12	M 12	M 12	M 14	M 14
600								M 12	M 12	M 14	M 14
800									M 14	M 14	M 14
1000										M 14	M 14

Support 1250 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 8	M 8	M 8						
150		M 8	M 8	M 8	M 10					
200		M 8	M 8	M 10	M 10	M 10				
250			M 8	M 10	M 10	M 12	M 12			
300				M 10	M 10	M 12	M 12	M 12		
400					M 12	M 12	M 12	M 14	M 14	
500						M 12	M 12	M 14	M 14	M 14
600							M 14	M 14	M 14	M 14
800								M 14	M 14	M 16
1000									M 16	M 16

Support 1500 mm (c.t.c.)

H	B	200	250	300	400	500	600	800	1000	1200
100		M 8	M 8	M 8						
150		M 8	M 8	M 10	M 10					
200		M 8	M 10	M 10	M 12	M 12				
250			M 10	M 10	M 12	M 12	M 12			
300				M 10	M 12	M 12	M 12	M 14		
400					M 12	M 12	M 14	M 14	M 14	
500						M 14	M 14	M 14	M 14	M 16
600							M 14	M 14	M 14	M 16
800								M 14	M 16	M 16
1000									M 16	M 16

2.19.7 Table dimensions threaded rods – circular air duct WM EIS 60 mesh blanket

Support 1000 mm (c.t.c.)

air duct diameter mm	200	250	300	400	500	600	800	1000	1200
threaded rod	M 6	M 6	M 6	M 8	M 8	M 8	M 10	M 12	M 12

Support 1250 mm (c.t.c.)

air duct diameter mm	200	250	300	400	500	600	800	1000	1200
threaded rod	M 6	M 8	M 8	M 8	M 10	M 10	M 12	M 12	M 14

Support 1500 mm (c.t.c.)

air duct diameter mm	200	250	300	400	500	600	800	1000	1200
threaded rod	M 8	M 8	M 8	M 10	M 10	M 12	M 12	M 14	M 14

2.20 Assembly instructions

2.20.1 General

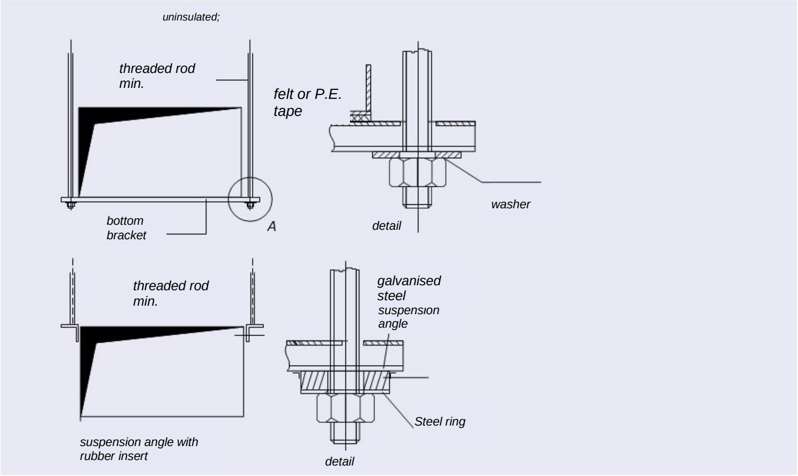
Within the framework of the agreement between Luka and TÜV Rheinland Nederland B.V. the checking of the manufacturing and assembly quality by TÜV Rheinland Nederland B.V. is guaranteed. Safety, health and the environment are also important issues in assembly work. In accordance with Working Conditions Act and the VCA checklist, the various parties on the construction site have their own specific responsibilities. For example, the main contractor has final responsibility for safety on the project and the provision of general facilities and safety equipment. As a subcontractor, the Luka members have, among other things, the responsibility for the correct actions of their employees and for providing them with the right resources. Usually all this is laid down in a project plan. If required and possibly in consultation with the client, the Luka members will provide an in-house project plan. This plan serves as part of the total project plan provided by the main contractor.

2.20.2 Transport and storage

The transport of air ducts must take place in a responsible way, so that transport damage is prevented. It is recommended to use boxes, net bags, bundles, crates or containers for transport of circular fittings. Air ducts are sensitive to deformation by careless or rough handling. Careful unloading is therefore a necessity. Damage to the connection profiles on rectangular ducts and at the edges of circular ducts increases the risk of air leakage. In order to prevent damage as much as possible, it is recommended that deliveries to the construction site are closely coordinated with the progress of assembly. Damages will be treated as follows:
-scratches which have led to localised removal of the zinc layer are treated on site with an anti-corrosion zinc dust paint;
-dents in the duct, which reduce the passage shall be fixed locally
so that the free flow of the duct is guaranteed at least 95 %;
-joints that have been damaged are repaired in such a way that the
prescribed structural strength and airtightness in accordance with this design specification is maintained.
If no description is given in the specifications (see 2.12), storage on the construction site can take place in the open air or in the building shell. In both cases the ducts must be stored on a dry surface. When stored in the open air, the ducts must be protected against extreme weather conditions and pollution. After delivery to the construction site, the air ducts and fittings should be stored as close to the installation site as possible by crane or hoist.

2.20.3 Mounting instructions for rectangular and circular air ducts

At the start of each assembly, the assembly supervisor must be in possession of assembly drawings and/or material lists. The assembly supervisor must also explain the content of the assembly instructions and the specific regulations applicable to the construction site.



2.20.4 Suspension and support of uninsulated rectangular metal ducts

The air ducts are fixed or suspended in such a way that the duct parts with fittings form a stable and tight whole. The choice of materials and construction takes into account the surrounding conditions and the linear expansion of the duct material. The most common constructions are:

- Consoles, galvanised or at least finished with zinc dust paint, used for fixing against a building structure;

- Suspension structures, which are of such strength that the total weight of the air ducts, including the intermediate fittings, is transferred to the structural suspension points by threaded rods;

- Duct corners with rubber insert.

The suspension must consist of a lower bracket of Sendzimir galvanised material, provided with felt or P.E. tape with minimum dimensions of 18 x 4 mm, with threaded rods minimum M6, directly along the duct. The distance between these threaded rods and the duct wall is maximum 50 mm and minimum 15 mm. The brackets, with a mutual distance of 3 metres maximum centre-to-centre, can be executed in a profile form, or in a standard commercial profile of sufficient strength, so that sufficient stiffness is obtained. See table below.

applicable Sendzimir-galvanised bottom bracket (in mm)

		min. dimension			
duct width		width	x	height	min. thickness
≤	800	28	x	15	1.25
≤	1,250	30	x	20	1.5
>	1,250	30	x	40	1.8

2.20.5 Suspension and support of shaft ducts

For shafts, consoles can be used against the wall, or profiles on the shafts, which are supported on the floor. The steel constructions will be made at least anti-corrosive.

2.20.6 Suspension and support for post-insolation of ducts

If the ductwork is insulated externally after installation, MDF spacer blocks 50 x 50 x 25 or hard pressed insulation strips 100 x 25 mm must be fitted between the bottom bracket and the duct.

2.20.7 Suspension and support of circular metal ducts

Circular air ducts are fixed or suspended so that the duct parts and fittings form a stable and tight whole. The choice of materials and construction takes into account the surrounding conditions and the linear expansion of the duct material. The most common constructions are:

- consoles, galvanised or at least finished with zinc dust paint, used for fixing against a building structure;
- suspension structures, which are of such strength that the total weight of the air ducts, including the intermediate fittings, is transferred to the structural suspension points by threaded rods;

The brackets for pipes with a diameter of > 450 mm must be designed as two- point suspension with an upper and lower bracket. Felt or P.E. tape with minimum dimensions of 18 x 4 mm should be applied. For smaller diameters it is sufficient to use one-point brackets made of Sendzimir-galvanised steel tape or mesh tape, provided with felt or P.E. tape with the minimum dimension of 18 x 4 mm, or plastic coated mesh tape with one-point suspension.

In addition, standard brackets with rubber insert can be used. The maximum centre-to-centre distance between the brackets is 3 metres. For shafts, consoles can be used against the wall, or profiles on the shafts, which are supported on the floor. The steel constructions will be made anti-corrosive.

2.20.8 Suspension and support of rectangular plastic, mineral wool and hard foam ducts.

Rectangular air ducts are fixed or suspended so that the duct sections with fittings form a stable and tight unit. The choice of materials and construction, the environmental conditions and the linear expansion of the duct material are taken into account. The most common constructions are:

- Consoles, galvanised or at least finished with zinc dust paint, used for fixing against a building structure;
- Suspension structures, which are of such strength that the total weight of the air ducts, including the intermediate fittings, is transferred to the structural suspension points by threaded rods;

Suspension is by means of a top and bottom bracket with threaded rods at least M6, directly along the duct. The distance between these threaded rods and the duct wall is maximum 50 mm and minimum 15 mm. The brackets, with a mutual distance of 3 metres maximum centre-to-centre, can be executed in a profile form, or in a standard commercial profile of sufficient strength, so that sufficient stiffness is obtained. See table below.

applicable Sendzimir-galvanised bottom bracket (in mm)

		min. dimension			
duct width		**width**	**x**	**height**	**min. thickness**
≤	800	28	x	15	1.25
≤	1,250	30	x	20	1.5
>	1,250	30	x	40	1.8

Roof ducts support, by means of weather resistant support profiles, the roof facilities installed by the building contractor. These support profiles are a maximum of 2.5 metres centred on each other lengthwise.

2.20.9 Suspension and support of circular plastic ducts

These air ducts are fixed or suspended in such a way that the duct parts with fittings form a stable and tight whole. The choice of materials and construction takes into account the surrounding conditions and the linear expansion of the duct material.

2.20.10 Supporting roof ducts

Roof ducts support, by means of weather resistant support profiles, the roof facilities installed by the building contractor. These support profiles are a maximum of 2.5 metres centred on each other lengthwise.
Open-ended roof ducts (intake and exhaust ventilation ducts) must be anchored to a third-party construction that is part of the overall roof structure to prevent storm damage.

2.20.11 Suspension of air ducts and fittings with flexible suspension systems.

Flexible suspension systems are also used in addition to suspension and mounting with threaded rods. Unlike threaded rod suspension and assembly, the threaded rod is replaced by a flexible suspension medium such as steel cable or band, and the bolt / nut fixing and securing are replaced by a clamping device. Reasons for applying these suspension systems are mostly aesthetics, faster suspension and adaptability.

Luka recommends to check the equivalence of flexible suspension systems for air ducts and fittings with the above described suspension with threaded rods on the following elements:

- Fire resistance of suspension material;
- Bearing capacity of suspension material;
- Molest risk of suspension material;
- Durable securing of clamping device;
- Risk of damage and deformation of air ducts, fittings and insulation.

2.21 Airtightness of air transport route

2.21.1 General

Luka strives, in close cooperation with suppliers and/or manufacturers of fittings, to limit the occurring air leakage of the air transport route and with that reduce the energy consumption of the air-conditioning installation. The air transport route should be understood to mean

- air ducts;
- between fittings to be mounted;
- flexible hoses and vent plenums.

2.21.2 Airtightness of air ducts

Only in exceptional cases should a duct system be completely airtight. For safety reasons, a leak is not permissible, for example, in the case of transporting dangerous gases or heavily polluted air. A duct system for a ventilation and air conditioning system manufactured in accordance with standard production methods will show a certain degree of leakage at joints and connections. It is desirable to establish the permissible amount of air leakage for reasons of economy and disturbance. Although the leakage occurs at the cross-connections and longitudinal connections, especially at the corners, it is assumed that the amount of air leakage is proportional with the duct wall surface area. Research has shown that the amount of air leakage per m^2 of wall area can be written as:

ø LA = f.Ps0.65 (l / s.m^2) where:
ø LA = amount of air leakage per m^2 surface area
f = leakage factor
PS = static pressure in Pa

static pressure (P_a)	**maximum leakage rate (1/s .m2)**			
	class A (ATC 5)	class B (ATC 4)	class C (ATC 3)	class D (ATC 2)
500	1.53	0.51		
1000		0.80	0.27	0.089
1250			0.31	0.103
1500			0.35	0.116
2000			0.42	0.14

2.21.3 Classes of airtightness

The permissible amount of air leakage is related to airtightness classes, for which a test pressure applies, which is taken from NEN-EN 1507 and 12237. LUKA members test the airtightness only at overpressure. The following classes are used internationally:

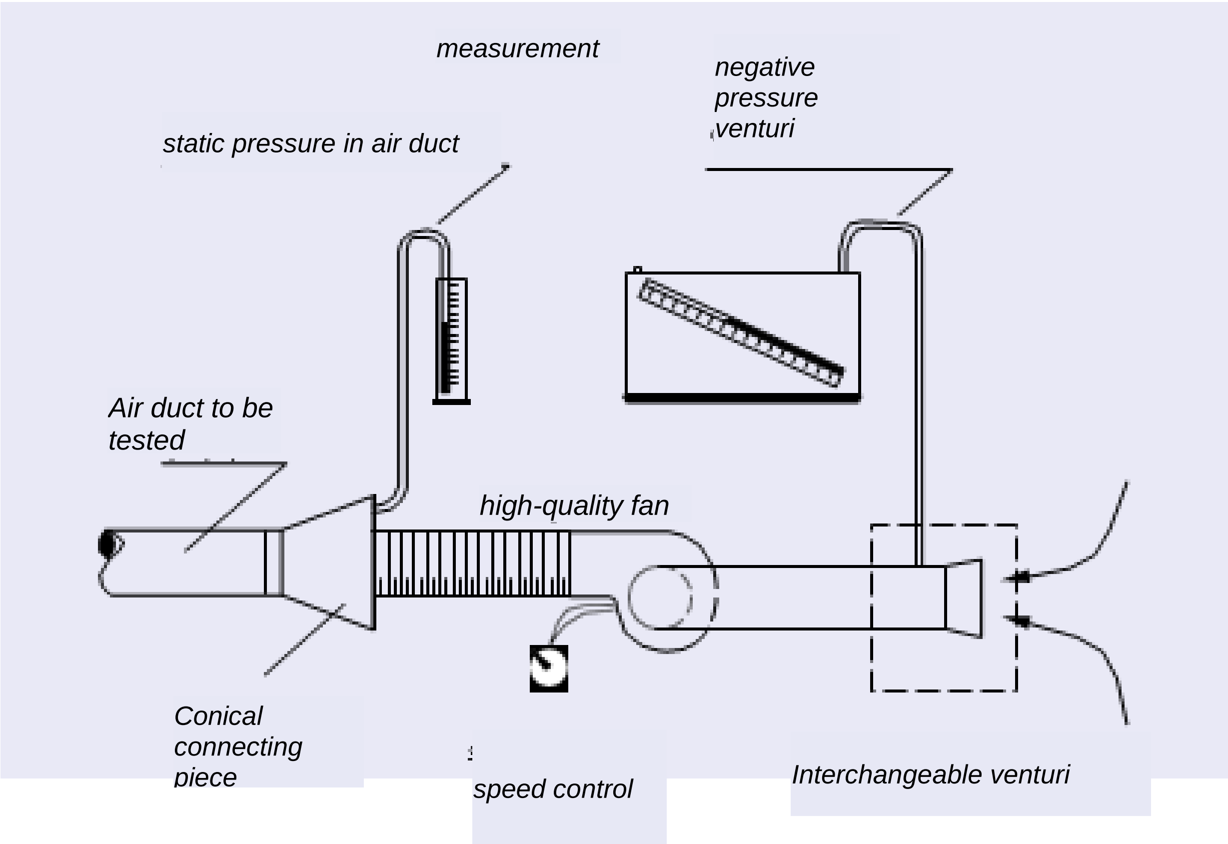
Density class		Air leakage limit (f max)	
Future	Current		(in m3/hm2)
ATC 5	A	0.027	. pt 0.65 . 10-3
ATC 4	B	0.009	. pt 0.65 . 10-3
ATC 3	C	0.003	. pt 0.65 . 10-3
ATC 2	D	0.001	. pt 0.65 . 10-3

If not indicated otherwise in the specifications, Luka uses class C as standard requirement for airtightness. By measuring it can be determined whether the investigated section of the duct complies with the requirement set. In practice, after measurement with a suitable test device, the degree of leakage is immediately assessed using a graph, which shows the maximum permissible air leakage for fitted duct sections for the given tightness class C. For the execution of the leakage test the following shall be observed: the part to be tested is mounted, but preferably not provided with external insulation; the part to be tested is airtight separated from the rest of the system and provided with any intermediate fittings for which the test requirements are fixed; if a total duct system, i.e. the air transport route, is assessed, the part to be tested has a surface area of at least 10 m² and at most 80 m²; (depending on the capacity of the test equipment) the part to be tested is held at the test pressure (=test pressure) for 5 minutes before the leakage volume flow is measured; a maximum of 1% of the total area of the duct project will be tested. By default, 1 press test is performed per project; the deviation from the test pressure may be about 20 Pa.

2.21.4 Principle of operation

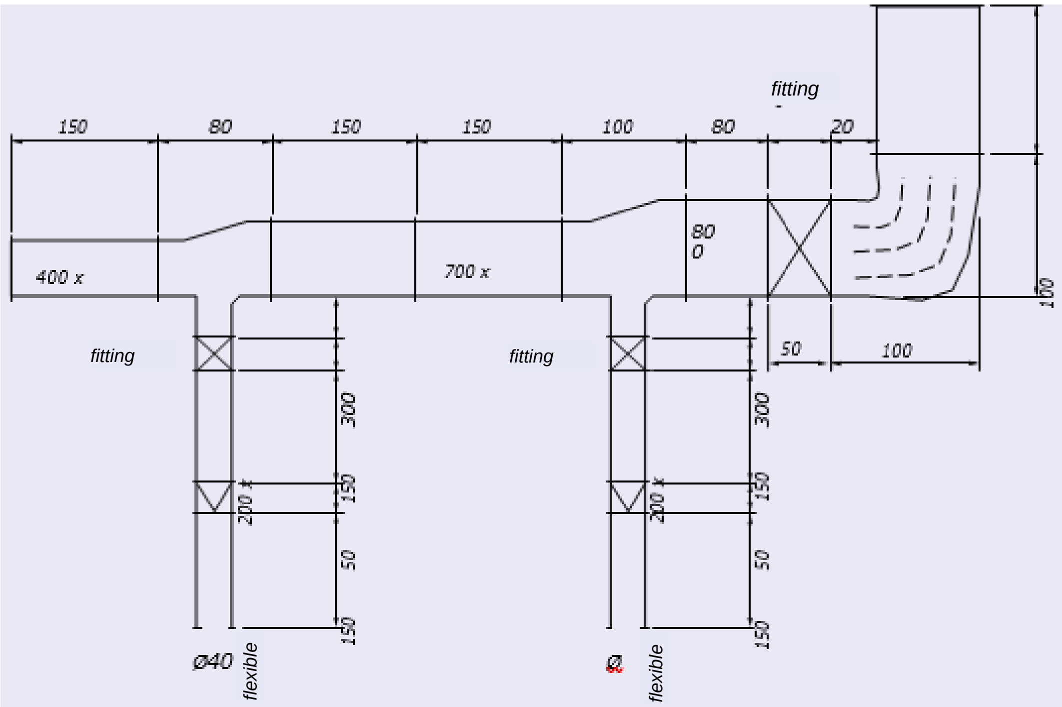
The leak tester basically consists of a fan with adjustable speed, a manometer to measure the pressure in the air duct, a calibrated inlet piece (venturi) and an accurate manometer to measure the suction pressure in the venturi. 3 different inlet pieces are supplied (each with its own curve) to cover the entire range of the leak tester.

When the leak tester is connected to the duct section to be tested, the speed is controlled in such a way that the required test pressure is maintained within the set margin. The amount of air lost through leakage is indicated via the venturi of the leak tester. By reading the oblique pipe manometer, the air leakage in l/s in the table can be read on the leak tester. The measuring instrument shall be calibrated once every 3 years and shall have a measurement accuracy of ± 5 %. In addition to the leak tester described above, it may also be designed in such a way that it can be read digitally. Due to the permanent accuracy, calibration can happen once per 5 years. This is described in EN 1507 and EN 12237.



2.21.5 Determination of the surface of the duct to be tested

The following table shows the determination of the number of m² of system surface area to be used in the air leakage formula. In the table, a length of 1000 mm is used for the fitting unless the actual length exceeds 1 metre. Then the actual length is filled in (see also 6.2 Method of measurement).



800 x 400	1.5 + 1.0 + 1.0 + 1.0 (app) + 0.8 + 1.0	= 6.3 x 2.4	15.12m²
700 x 400	1.5 + 1.5 + 0.8	= 3.8 x 2.2	8.36m²
400 x 400	1.5	= 1.5 x 1.6	2.40m²
200 x 400	0.2 + 1.0 (app) + 1.5 + 0.5 + 0.2 + 1.0 (app) + 1.5 + 0.5	= 6.4 x 1.2	7.68m²
ø400	1.5-+1.5	= 3 x 3.14 x 0.4	3.77m²
		duct area	37.33m²

2.22 Internal cleanliness of new air ducts and associated fittings and components

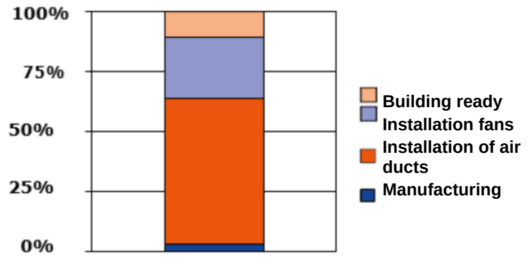
2.22.1 General

The presence of dirt inside air transport routes during construction and before completion of new installations is increasingly being considered unacceptable. After being put into service, this dirt can have a negative impact on the service life of the system and system components and can also have a negative impact on the indoor air quality in buildings.

Internal contamination of the air transport routes in new installations in buildings occurs at various stages of the construction process, namely:
Production externally and supply of the components of the air transport route;
1.Storage of the components of the air transport route at the construction site;
2.Installation/assembly of the air transport route;
3.Completion of the building after completion of air transport routes;
4.Building heat supply and trial run of the plant before transfer.

Figure 1 shows indicatively what the different stages in a standard process without special provisions contribute to the internal contamination of the air ducts.

Figure 1



Most contamination occurs during the installation process of the air transport route at the construction site. The Luka members can reduce this pollution to a large extent by taking adequate measures. Internal contamination can still be caused by the destructive and polluting influence of third parties at the construction site during the installation of the air transport route and by polluting activities after the installation of the air transport route.

A Luka-member cannot be held responsible for this last mentioned pollution, of which he is not the cause.

Luka however feels socially involved in realizing internally clean air transport routes as far as this lies within our possibilities.
This chapter has been prepared for those involved in the process of building air transport routes, who have also set themselves the goal of achieving internally clean air transport routes.
To this end, the following topics are described in this chapter: Research Luka and European standard NEN EN 15780;
Luka Cleanliness Classes;

- Responsibilities of those involved in obtaining internally clean air transport routes;
- Recommendations inspection hatches;
- Specifications;
- Recommendations for executive Luka members;
- Measuring the Luka Cleanliness Class;
- Measurement report Luka internal cleanliness class.

2.22.2 Research Luka and European standard NEN-EN 15780

In addition to visual inspections by the client and/or delegated client, Luka conducted research among designers of installations, standards and measuring methods.
This has resulted in the choice for standard ISO 8502-3 and the corresponding test method, because of the simplicity, unambiguousness and the possibility to perform the "Tape Test" on site, as described in ISO 8502-3.

The Luka cleanliness class is in no way connected to the NEN-EN 15780 standard. The NEN norm uses contamination levels in grams per m² of surface area. Luka uses contamination based on a comparison. The advantage of this is that the weight of the undesired contamination is not included in the assessment of the quantities of dust.

2.22.3 Luka Cleanliness classes

Luka uses three internal cleanliness classes (Luka Reinheidsklassen, LR): Luka Cleanliness Class L (LR-L): Low Cleanliness Class M (LR -M): Medium Luka Cleanliness Class H (LR-H): High

The Luka Cleanliness Class is not automatically linked to the Luka Airtightness Class and should be described separately in the specifications or principles. However, the Luka Cleanliness Classes are directly linked to and based on the international standard ISO 8502-3. This ISO standard uses five dust quantity ratings. These have been implemented in the Luka Cleanliness Classes as follows:
LR - L: ISO 8502-3, dust quantity rating 5 and higher. LR - M: ISO 8502-3, dust quantity rating 3 and 4. LR - H: ISO 8502-3, dust quantity rating 1 and 2.

2.22.4 Responsibilities of those involved in obtaining internally clean air transport routes

It will be clear that the Luka member can only be held responsible for the internal cleanliness of the air transport routes to the extent that the Luka member is allowed and able to check and control the conditions under which the activities can be executed. Responsibilities of those involved in obtaining internally clean air transport routes include:

Construction site
The construction site gives a good indication of the cleanliness of the ducts. At a cleaned-up construction site, the work is cleaner and this results in cleaner installations.

Storage

Material storage should be allocated in such a way that it is not in the vicinity of polluting building processes. This is described in more detail in the Luka Quality Guide in chapter "Assembly instructions".

Planning
Coordination of the work of the various disciplines affects clean installations. Polluting activities should be carried out separately in terms of time from clean installation activities.

If the air treatment installation has to be put into operation during the building process, additional provisions may be required. Temporary filters may need to be installed by third parties to protect the return ducts.

2.22.5 Recommendation inspection hatches

In order to be able to inspect the installation properly, a sufficient number of inspection hatches are required. The hatches should be fitted in the right place and be of sufficient size. Components with inspection hatches are preferred. In addition to the hatches for components requiring service which are not fitted with an inspection hatch, it is recommended that additional hatches are fitted in shafts, technical rooms and floors. The hatches must be easily accessible and be clearly indicated by the coordinating party on the drawing. NEN-EN 12097 should preferably be used as the basis for the inspection facilities.

2.22.6 Specifications

If there are requirements for the internal cleanliness of the air transport routes (including fittings and components), Luka recommends the following specifications:

The complete air transport routes, both supply and exhaust between the air handling unit(s) and the vent(s) (thus including components and vent plenums) must be delivered and installed according to the quality standards as set down in the Luka Quality Guide (latest version), whereby the internal cleanliness must at least meet Luka Cleanliness Class L (or M or H). When the air transport routes are reported ready for use the installation company must check and demonstrate this with a Luka Cleanliness Report.

2.22.7 Recommendations for executive Luka members

To realise a certain Luka Cleanliness Class, recommendations have been formulated for the executing Luka member. These recommendations clearly contribute to the realization of a certain Luka Cleanliness Class, but do not guarantee it.

2.22.7.1 Luka Cleanliness Class L (LR-L): Low

sealing openings in ductwork and components	no	the open ends of duct sections, pipes, fittings and components need not be sealed.
protection during transport:	no	the ducts and components may be transported in open vehicles.
protection during storage:	no	the ducts and components may be stored unprotected
sealing openings installed parts:	no	the open ends of installed installation parts do not have to be sealed. the open ends at the top of a shaft must be sealed properly by means of wood or steel. This sealing must be tightened in such a way that it cannot be removed easily.
grinding allowed:	yes	ducts may be processed with a grinder.
chipping allowed:	yes	ducts may be processed with a saw.
Self-drilling parker screws allowed:	yes	ducts and components may be connected by means of self-drilling parker screws.
plasma deposits:	yes	plasma deposits may be present on the ducts.
workplace	there are no requirements for cleanliness in the workplace.	
installation	no additional cleanliness operations are performed during installation.	

2.22.7.2 Luka Cleanliness Class M (LR -M): Medium

sealing openings in ductwork:	yes, if construction debris present	the open ends of ducts, pipes, fittings and components do not have to be sealed if no construction debris is produced at the construction site.
sealing openings of components and fittings:	yes	the open ends of components and fittings shall be sealed individually.
protection during transport:	yes	the ducts and components must be transported in closed means of transport.
protection during storage:	yes	the ducts and components must be stored protected against contamination. The storage location must be clean, dry and minimally exposed to contaminating conditions. This location should be provided by the client as stated.
sealing openings installed parts:	yes	the open ends of installed installation parts must be sealed. the seals must be of a closed material and provide sufficient sealing to prevent the entry of dust and dirt. the open ends at the top of a shaft must be properly sealed by means of wood or steel. this seal must be secured in such a way that it cannot be easily removed.
grinding allowed:	yes	ducts may be processed with a grinder.
chipping allowed:	yes	ducts may be processed with a saw.
self-drilling parker screws allowed:	yes	ducts and components may be connected by means of self-drilling parker screws.
plasma deposits:	yes	plasma deposits may be present on the ducts.
workplace	the workplace must be dry and clean before starting the installation. no dust- producing activities are carried out by third parties. the clean workplace must be provided by the client.	
installation	the duct parts and components are visually inspected before installation and, if necessary, cleaned using an adhesive wipe.	

2.22.7.3 Luka Cleanliness Class H (LR-H): High

sealing openings in ductwork and components	yes	the open ends of duct parts, pipes and components should be sealed. the seals should be made of a closed material and provide sufficient sealing so that the entry of dust and dirt is not possible. round fittings should be packed in closed bags, boxes and/or crates. the components should comply with this luka cleanliness class with a test report and should be provided with protection so that with this protection no contamination can occur on site in the components.
protection during transport:	yes	the ducts and components must be transported in closed vehicles.
protection during storage:	yes	the ducts and components must be stored protected against contamination. The storage location must be clean, dry and minimally exposed to contaminating conditions. This location should be provided by the client as stated.
sealing openings installed parts:	yes	the open ends of installed installation parts must be sealed. the seals must be of a closed material and provide sufficient sealing to prevent the ingress of dust and dirt. the open ends at the top of a shaft must be properly sealed by means of wood or steel. this seal must be secured in such a way that it cannot be easily removed.
grinding allowed:	no	ducts may not be processed with a grinder.
chipping allowed:	yes, provided chips are removed after process.	ducts may not be processed with a saw.
Self-drilling parker screws allowed:	no	ducts and components may not be connected by means of self-drilling parker screws.
plasma deposits:	no	there should be no plasma deposits on the ducts.
workplace	the workplace must be dry and clean before starting the installation. no dust-producing activities are carried out by third parties. the clean workplace needs to be taken care of by the Luka member's client.	
installation	the duct parts and components are visually inspected before installation and, if necessary, cleaned using an adhesive wipe.	

2.12.7.5 Oil and grease residues

In addition to particulate contamination, there may also be oil and grease residue contamination in the product after manufacture. Lubricants may be used in the manufacturing process. In some cases these lubricants can be undesirable. If Luka Cleanliness class M or H is required, the presence of oil and/or fat residues in the supplied product undesirable. This degree of contamination is measured using the surface energy.

If the specifications state oil or grease free, Luka uses a surface energy of 38mN/m as limit value for metal ducts.

If nothing is specified in the specifications, grease and/or oil residues resulting from the manufacturing process may be present.

If the specifier wishes a higher surface tension, this must be indicated in mN/m. It is important that the prescribed value can be met in connection with the naturally present surface energy of various materials.

2.22.9 Measuring oil and grease residue

Supplies:

- Test pin 38mN/m
- Cotton swab (Allowed for test tint)

NB. The test materials to be used shall be Arcotest or equivalent. A felt-tipped pen or other cotton buds are not permitted in connection with possible contamination of the ink/fluids. This may result in an erroneous assessment.

The test procedure is as follows:

1. Press the pen to the surface so that the tip springs back for a fresh dose of ink;
2. Apply the test ink with a length of at least 6 cm;
3. Clock the time in which the ink reacts, see possible observations below:
   - The test ink becomes pearly within 2 seconds
   - The test ink becomes pearly between 2 and 3 seconds
   - The test ink becomes pearly after more than 3 seconds
4. Take 3 tests, if all tests give the same result then that result is the conclusion;
5. If there is an abnormal result then two additional tests should be done;
6. If 4 out of 5 tests give the same result then that result is the conclusion;
7. If there is an outcome ratio of 2:3 then the majority is the conclusion.

2.22.10 Measuring the Luka Cleanliness Class.

The method of measuring internal cleanliness is based on the international standard ISO 8502-3. The test equipment is an Elcometer dust test or equivalent. A standardised adhesive tape is used to remove contaminants from the duct following the procedure described in ISO 8502-3.

The tape is applied to the Luka Cleanliness Test Report version 8-12. Because of this, the substance is contaminated and can be compared with the reference frames on the report. Although the Luka standard is based on the ISO standard, testing and reporting according to ISO is not allowed. Only the Luka test form is allowed and it also functions as an official report.

The measurement method is designed in such a way that it gives immediate results. It is possible to carry out a test at various stages during the construction process.
In the specifications it has to be indicated which Luka Cleanliness Class and at which moments during the building process a Luka Cleanliness Test report is required.

Cleanliness measurement of dust particles

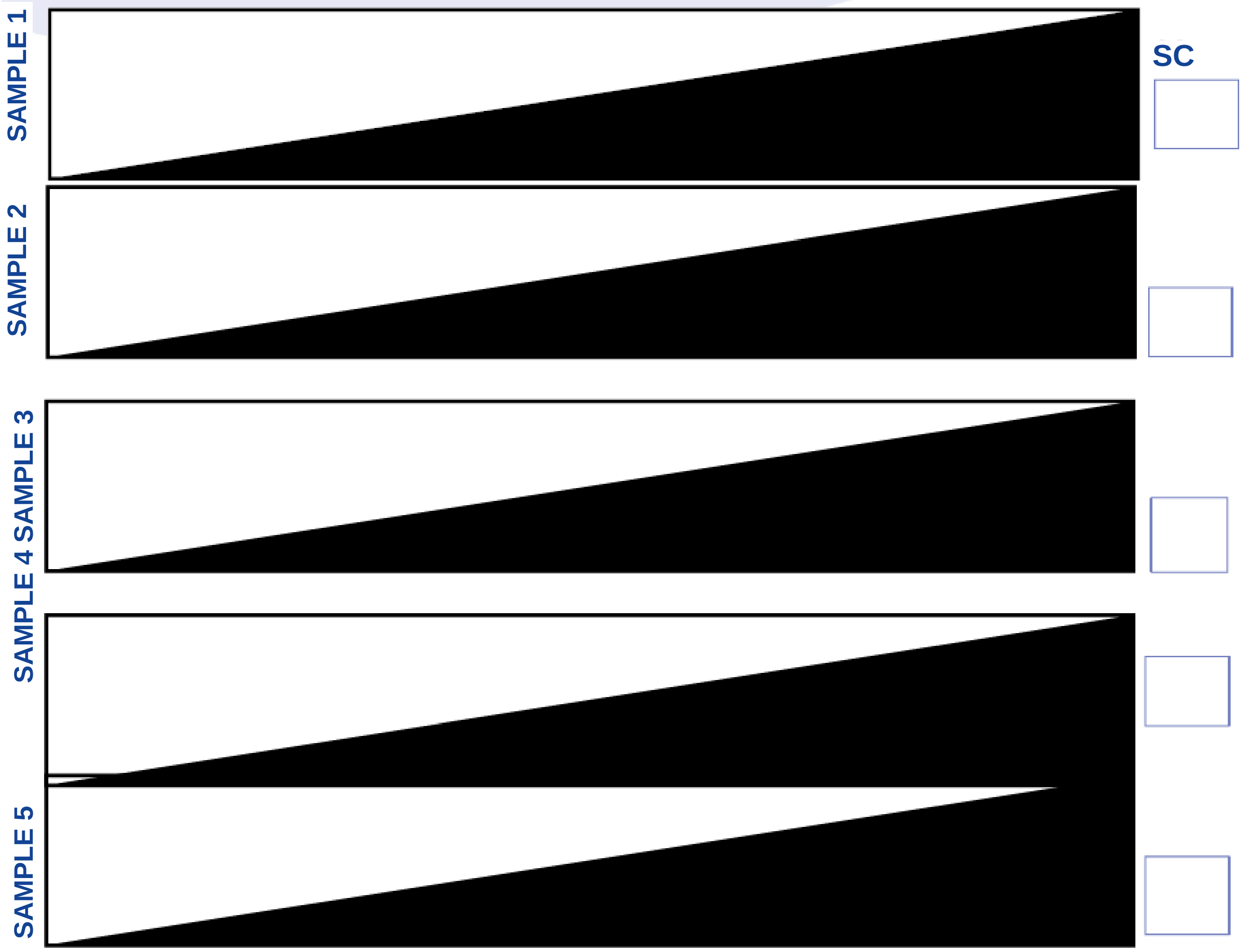
Project:..

Project number:............................... Test conducted by:... d.d .... - ....- ....

Present	On behalf of	Signature approval

Adhesive tape: Elcometer 142 (T9999358) Standardised according to ISO 8502-3

Component: ....



DUST CLASSIFICATIONS (SC)

1	**2**	**3**	**4**	**5**

2.22.11 Method of measurement

Supplies:
– Luka test forms;
- Magnifying glass with a magnification factor of 10;
- Certified self-adhesive tape complying with ISO 8502-3;
- Pressure roller complying with ISO 8502-3 (not mandatory).

The first three turns of the tape should be removed before starting a test. A test consists of several samples, so it is not necessary to do this for every sample.

A strip of tape of at least 200 mm in length shall be cut and touched at the ends only. The tape should be firmly pressed to the internal surface to be tested over a length of at least 150 mm. Then the tape should be rubbed with the thumb with firm pressure three times for about 5 seconds at a time. Alternatively, this can be done with a pressure roller. The pressure roller should exert a pressure between 39N and 49N.

Carefully remove the tape and apply it to the Luka Cleanliness Test Report "Luka Technical Paper 3 Rev.1. There should be 3 samples per section per test. Using the magnifying glass, compare the tape with the reference frames.

If all three samplings at least match the requirement then the tested is agreed. If there is a maximum of one deviation, two additional samples must be taken. If these two supplementary samples both at least comply with the requirement, the test is still approved. In all other cases, the requirement is not met.

The form must be approved by a witness on site. The Luka-member keeps the form and provides a copy as a report. The original contains the contaminated substance and can be re-evaluated afterwards if required.

Chapter 3 Quality standards for fittings

3.1.1 General
In this part of the Quality Guide intermediate fittings in the air duct systems are discussed. The quality standards and the assembly of the fittings in the air duct system will be dealt with.

The objective is to have the total air transport route, between the air handling unit and the vent, comply with the Luka quality requirements.

3.1.2 Airtightness of fittings (general)
The air leakage occurring in the air transport route must be limited in order to minimise the energy consumption of the air-conditioning installation. The basic principle is that if the air ducts meet the airtightness requirements, then airtightness requirements must also be set for the intermediate fittings. These airtightness requirements are the same as those internationally agreed on in the NEN-EN 1751, 13180 and 15727 (depending on the type of fitting). In the Quality Guide the standard to be applied for each fitting is mentioned. Unless stated otherwise in the specifications, Luka uses class ATC 3 as the airtightness requirement. Fittings therefore have to meet at least airtightness class ATC 3. Fittings with circular connections with rubber "safe" seals are preferable, as they make it possible to meet the airtightness requirements for the entire air transport route more efficiently. The use of safe seals does not increase the airtightness of the fitting itself.

3.1.3 Internal cleanliness of fittings (general)
It is recommended to protect the fittings from contamination. Fittings with circular connections can be fitted with dust caps for this purpose. Fittings with rectangular connections can be covered with foil or fitted with dust caps. If the dust caps and/or foil are only removed when the relevant connection is actually connected to the air duct system, the degree of contamination is minimised.
To be able to inspect the installation properly, sufficient inspection hatches are required. The hatches should be fitted in the right place and be of sufficient size. Components with inspection hatches are preferred. In addition to the hatches for components requiring service which are not fitted with an inspection hatch, it is recommended that additional hatches are fitted in shafts, technical rooms and floors. The hatches must be easily accessible and be clearly indicated by the coordinating party on the drawing. NEN-EN 12097 should preferably be used as the basis for the inspection facilities.

3.1.4 Transport and storage of fittings (general)
The transport and storage of accessories must take place in a responsible manner, in such a way that transport damage is prevented. Fittings are sensitive to deformation due to careless or rough handling.
Careful unloading is therefore a necessity. Damage to fittings increases the risk of leaks. It is therefore advisable to use wooden (or plastic) crates, boxes for transport When supplying to the air duct company, transport and storage should be carried out under the responsibility of and by the customer. Fittings must be delivered on time and carefully stored near the place of assembly. Premature delivery can lead to contamination or damage during construction. Delayed delivery results in additional costs due to more difficult assembly and a separate assembly cycle with the risk of air leaks.

3.1.5 Assembly instructions of fittings (general)

In this part, general assembly instructions for both rectangular and circular fittings are explained in more detail. For specific product related mounting instructions the supplier should be contacted.

Connections

Fittings are available with circular and rectangular connections. The circular connections are provided with a rubber sealing ring for an airtight connection to the air duct system. The rectangular connections are provided with a flange edge according to NEN-EN 1505 or ISO 13351, so that the fitting can be securely connected to the air duct system. To prevent leakage or damage, drilling, etc., other than in the flange should be avoided during assembly.

3.1.6 Assembly instructions for rectangular fittings

Rectangular fittings must be assembled in accordance with the manufacturer's instructions. These assembly instructions meet the requirements of NEN-EN 1505 to 1507. The components must be fixed or suspended so that they form a tight and stable unit with the air ducts. This is done with suspension structures that must have a strength such that the total weight is transferred to the structural suspension points by threaded rods.
The suspension is composed of a lower bracket of Sendzimir galvanised material (or other material if this is specified in the specifications), provided with felt or P.E. tape, with minimum dimensions of 18 x 4 mm, with threaded rods at least M6 directly along the fitting. The distance between the threaded rods is maximum 100 and minimum 30 mm larger than the duct width, depending on the presence of external insulation. The bracket must be mounted at a minimum distance of 100 mm and a maximum distance of 400 mm in front and behind the fitting and must be executed in a profile form (see table below) or in a standard commercial profile of sufficient strength, giving sufficient stiffness.

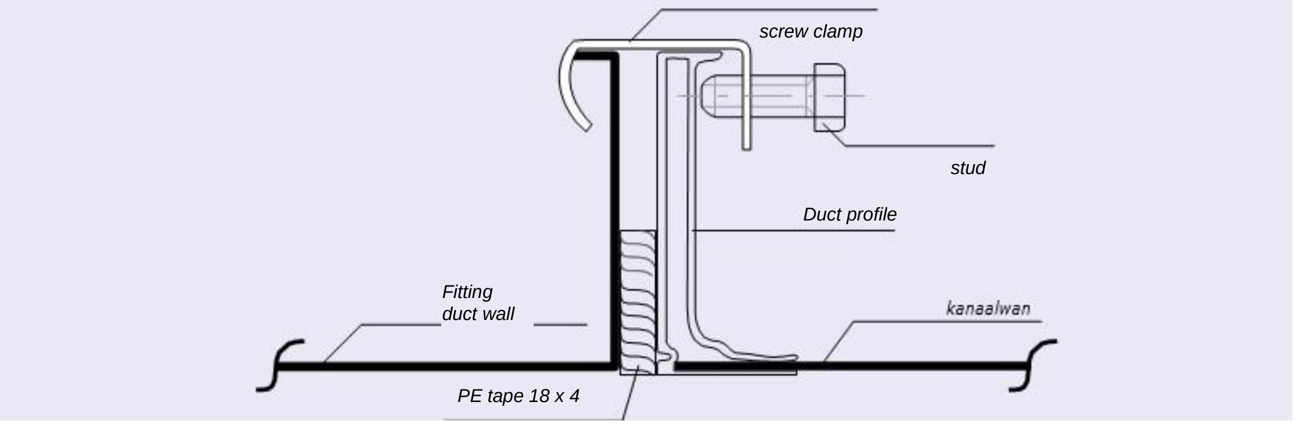
fittings width (mm)	min. dimension width x height	min. thickness
≤ 800	28 x 15	1.25
≤ 1,250	30 x 20	1.5
> 1,250	30 x 40	1.8

Because the flanges of the air ducts do not always match the flanges of the fittings, there are various ways of connecting them.

When the flanges are made with the same profiles, the corners are provided with a bolt and nut connection (at least M6 x 20) and/or with a profile in length and width. A sealing band with closed cell structure with minimum dimensions of 18 x 4 mm must be applied between the flanges, with the strap tensioned or verlapping at the corners (see 2.1.1.3).

- If the flanges are not made of the same profiles, the angles will be provided with a bolt + nut connection (at least M6 x 20) and with screw clamps at a maximum distance of 500 mm.

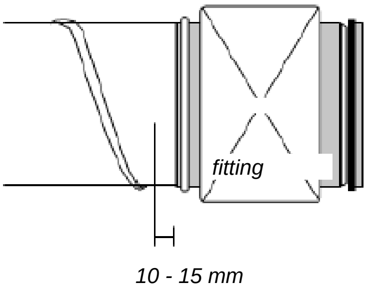
A closed cell sealing tape with minimum dimensions of 18 x 4 mm must be applied between the flanges, with the tape passing through the corners without tension or overlapping at the corners.

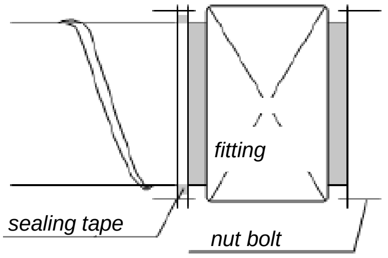


3.1.7 Assembly instructions for circular fittings

There are 2 different ways to attach the circular fittings to the circular air ducts:

- The fitting is fitted with a plug-in flange (with or without a rubber insert or "safe" joint). The sliding part is pushed into the spirally seamed pipe and fixed with rivets or self-drilling screws. When no safe connection is used, the connection will have to be wrapped with a suitable tape (see 2.1.3.11 Connections);
- The fitting is fitted with a right angle flange. The flange that is attached to the fitting is fitted with a contrasting flange. A closed cell sealing tape with a minimum dimension of 18 x 4 mm or an elastic permanent sealant will be applied between both flanges. The flanges are then connected to each other using a minimum of M6 bolts.





Fittings, fitted with round connections equipped with "safe" connection are preferable, as this allows air density requirements to be met more efficiently.

3.1.8 Assembly instructions of fittings (general)

In order to be able to inspect the installation properly, a sufficient number of inspection hatches are required. The hatches should be fitted in the right place and be of sufficient size. Components with inspection hatches are preferred. In addition to the hatches for components requiring service which are not fitted with an inspection hatch, it is recommended that additional hatches are fitted in shafts, technical rooms and floors. The hatches must be easily accessible and be clearly indicated by the coordinating party on the drawing. NEN-EN 12097 should preferably be used as the basis for the inspection facilities.

Insulation
The insulation must be installed in accordance with the manufacturer's instructions.
Specifically in the case of fibrous material (internal insulation), seams and the like must be finished in such a way that the fibrous material cannot be carried away by the air current.

3.1.9 Luka Appendage Register (LAR)

In order to be able to guarantee the airtightness, class ATC 3, of the air transport route, the Luka members must have the results of airtightness measurements on fittings at their disposal.

In the “Luka Appendage Register”, the so called LAR, these results are listed by type of fitting, with associated supplier. The standard to be used for measuring the airtightness is shown in the register.

Since Luka members apply a minimum class ATC 3 for the airtightness of the air transport route, the fittings must also comply with at least this class. Fittings included in the LAR comply with the assembly instructions in accordance with NEN-EN 1505 to 1507 and have an airtightness of at least class ATC 3.

The LAR distinguishes 17 fittings, the quality standards for each of which are described below:

For the current LAR see www.luka.nl.

3.1.10 Heating for duct installation electric

Function
An electric heater for duct installation, or electric duct heater, is used in an air transport system to heat air. The heat is transferred through electricity (230 or 400 Volt).

Material quality and thicknesses
For normal comfort ventilation, electric heaters for duct installation are manufactured from the following materials:
Casing: Sendzimir galvanised steel or Alu-zinc sheet material;
Heating element: stainless steel EN 1.4301;
Protection class: at least IP 43;
Other choice of material, depending on the application, in consultation with the supplier.

Connections
The electric duct heater is available with circular and rectangular connections.

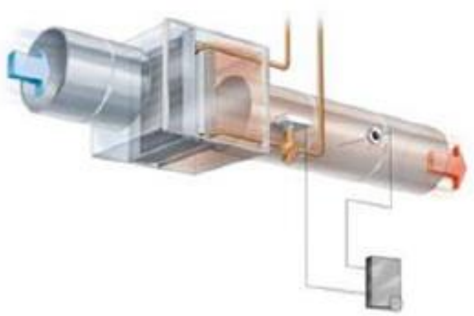
Dimensions
The available nominal dimensions of the intermediate electrical heaters are standardised according to NEN-EN 1505 (rectangular connections) and NEN- EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as referred to in this guide in sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

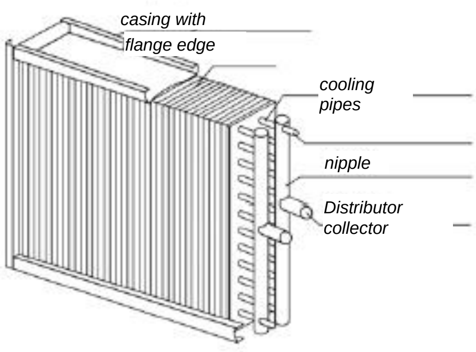
Assembly instructions
Electrical heaters shall be installed in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.

Sustainability aspects
Built-in heaters with circular connections are more efficient to connect to the air ducts than heaters with rectangular connections and contribute to the airtightness of the air duct system, if these fittings have sufficient airtightness according to NEN-EN 1572.

3.2.2 Heating for duct installation - hot water

Function
A hot-water heater for duct installation, or hot-water duct heater, is used in an air transport system to heat air. Heat transfer takes place through hot water. Material quality and thicknesses.





For normal comfort ventilation, hot water heaters for duct installation are manufactured from the following materials:

- Casing: Sendzimir galvanised steel or Alu-zinc sheet material heating element:
- Pipes: copper
- Slats: aluminium;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The hot-water duct heater is available with circular and rectangular connections.

Dimensions
The available nominal dimensions of the intermediate warm water heaters are standardised according to NEN-EN 1505 (rectangular connections) and NEN- EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as referred to in this guide in sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Inspection possibilities
It must always be possible to inspect intermediate hot-water heaters for leaks and contamination. To this end, the heater must be equipped with a removable inspection cover. This cover is attached to the housing in an airtight manner.

Assembly instructions
Hot-water duct heaters should be fitted in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.

Sustainability aspects
Built-in heaters with circular connections are more efficient to connect to the air ducts than heaters with rectangular connections and contribute to the airtightness of the air duct system, if these fittings have sufficient airtightness according to NEN-EN 15727.

3.2.1 Cooler for duct installation

Function
A cooler for ducts, or duct cooler, is used in an air transport system to cool air.
The energy transfer takes place by means of cold water.

Material quality and thicknesses
For normal comfort ventilation, ducted chillers are manufactured from the following materials:
- Casing: Sendzimir galvanised steel or Alu-zinc sheet material;
- Cooling element:
    - Pipes: copper
    - Slats: aluminium;
- Condensation drip pan: stainless steel.

Coolers should be provided with a drip catcher and a drip tray, with a provision for condensation drainage with an intermediate siphon and with sufficient height to compensate for the pressure difference that occurs.
The discharge pipe must also be provided with a pressure-free discharge.
Other choice of material, depending on the application, in consultation with the supplier.

Connections
The duct cooler is available with circular and rectangular connections.

Dimensions
The available nominal dimensions of the intermediate coolers are standardised according to NEN-EN 1505 (rectangular connections) and NEN- EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as referred to in this guide in sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Inspection possibilities
It must always be possible to inspect intermediate humidifiers for leaks and contamination. For this purpose, the cooler must be equipped with a removable inspection cover. This cover is attached to the housing in an airtight manner. It provides access to both sides of the battery, as well as to the condensation drip pan.

Assembly instructions
Duct coolers must be installed in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.

The duct cooler can only be used in horizontal air flows because of the condensation discharge. To this end, the cooler is equipped with a stainless steel condensation drip pan. A minimum distance from or to a bend, fan, valve, etc. must be taken into account. For circular measuring stations a minimum distance of 2 x the connection diameter is recommended. For rectangular coolers, a minimum distance of 1 x the connection diameter is recommended. For circular coolers, a minimum distance of 2 x the connection diameter is recommended.

Sustainability aspects
Built-in coolers with circular connections are more efficient to connect to the air ducts than heaters with rectangular connections and contribute to the airtightness of the air duct system, if these fittings have sufficient airtightness according to NEN-EN 15727.

3.2.2. Adjustment valve - circular

Function
A circular valve is used in a circular air transport system to control and/or adjust air flow rates. The valve can also be used to shut off air flows completely if it is equipped with a rubber sealing ring around the valve blade.

Material quality and thicknesses
For normal comfort ventilation, adjustment valves are manufactured from the following materials:
- Casing: Sendzimir galvanised steel;
- Valve blade: Sendzimir galvanized steel or plastic, possibly with a rubber sealing ring;
- Adjusting and/or locking device: Sendzimir galvanized steel or plastic;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The valve has circular connections with a rubber sealing ring for an air tight connection to the ductwork.

Dimensions
The available nominal dimensions of the intermediate adjustment valves are standardised to NEN-EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions given in this guide under section 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Assembly instructions
Adjustment valves must be fitted in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.
A minimum distance from or to a bend, fan, valve, etc. must be taken into account. For circular measuring stations a minimum distance of 2 x the connection diameter is recommended. For round dampers a minimum distance of 2 x the connection diameter is recommended.

Sustainability aspects
Circular valves with rubber sealing rings can be efficiently connected to air ducts and contribute to the airtightness of the air duct system, if the fittings have sufficient airtightness in accordance with NEN-EN 1751.

3.2.3 Iris valve - circular

Function
An iris valve, iris control valve or diaphragm valve, is used in a circular air transport system to measure, control and/or adjust air flow rates.

Material quality and thicknesses
For normal comfort ventilation, iris valves are manufactured from the following materials:
- Casing: Sendzimir galvanised steel;
- Diaphragm valve: Sendzimir galvanized steel;
- Adjustment nut and lever: plastic;
- Other choice of material, depending on the application, in consultation with the supplier

Connections
The iris valve has circular connections, fitted with a rubber sealing ring for an airtight connection to the air duct system.

Dimensions
The available nominal dimensions of the intermediate iris valves are standardised to NEN-EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as mentioned in this guide under chapter 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

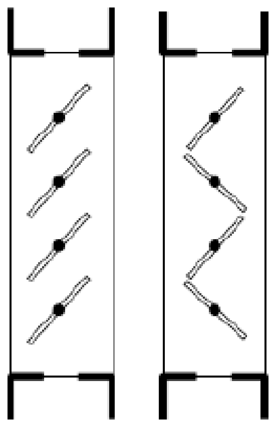
Assembly instructions
Iris valves must be installed in accordance with the regulations of the If present and they meet at least the requirements according to section 3.1.4.A minimum distance from or to a bend, fan, valve, etc. must be taken into account. For iris valves a minimum distance of 1 x the connection diameter is advised.

Sustainability aspects
Iris valves, fitted with rubber sealing rings, can be efficiently connected to air ducts and contribute to the airtightness of the air duct system, if the fittings have sufficient airtightness in accordance with NEN-EN 1751.
An iris valve, unlike standard adjustment valves, does not have a continuous axis, making it easy to clean the ductwork without removing the valve.

Due to the fact that iris valves can be cleaned more efficiently than standard control valves, savings can be made on maintenance.

3.2.4 Valve register - rectangular

equal-rotating ***contra-rotating***



Function
A rectangular valve register, or multileaf valve, is used in a rectangular air transport system to control and/or mix air flows. If the valve blades are fitted with a rubber seal, the valve register can also be used to seal off air flows completely. The valve register can be designed as equal or contra-rotating.

Material quality and thicknesses
For normal comfort ventilation, valve registers are manufactured from the following materials:

- Casing: Sendzimir galvanised steel;
- Valve blades (equal or contra-rotating):
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The valve register has rectangular connections and should be provided with a flange edge according to NEN-EN 1505 or ISO 13351, so that the fitting can be connected to the air duct system in a sound manner.
The valve register can also be provided with a circular connection flange (one or two sides), so that the fitting can be connected to a circular air duct system.

Dimensions
The available nominal dimensions of the intermediate-built valve registers are standardised to NEN-EN 1505 (rectangular connections) and can be chosen as indicated in the tables for standard dimensions, as mentioned in this guidel under chapter 2.1.1.6 (rectangular connections). The dimensions depend on the manufacturer.

Assembly instructions
Valve registers are to be fitted in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.

Sustainability aspects
Valve registers with circular connection flanges fitted with rubber sealing rings can be efficiently connected to air ducts and contribute to the air tightness of the air duct system, if the fittings have sufficient air quality according to NEN-EN 1751

3.2.5 Constant volume control

Function
A constant volume controller, CAV controller or CVC, is used in a ventilation system to keep a fixed flow rate constant. When the system pressure in front of the controller changes, the position of the valve blade is mechanically adjusted so that the flow rate remains constant. This flow rate can be easily read and adjusted on an external scale.

Material quality and thicknesses
For normal comfort ventilation, constant volume controls are manufactured from the following materials:

- Casing: Sendzimir galvanised steel;
- Valve blade: Sendzimir galvanized steel;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The constant volume controller is available with round and rectangular connections.

Dimensions
The available nominal dimensions of the intermediate constant volume controllers are standardised to NEN-EN 1505 (rectangular connections) and NEN-EN 1506 (round connections) and can be chosen as indicated in the tables for standard sizes, as mentioned in this guide in under sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Assembly instructions
Constant volume controls must be fitted in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4. The constant volume control should be installed in a horizontal or vertical duct with the rotation axis in a horizontal position.
A minimum distance from or to a bend, fan, valve, etc. must be taken into account. For circular measuring stations a minimum distance of 2 x the connection diameter is recommended. For circular constant volume controls, the minimum distance is 3 x the connection diameter is recommended. For rectangular constant volume controllers, a minimum distance of 3 times the duct width is advised.

Sustainability aspects
Constant volume controls with circular connections can be efficiently connected to air ducts and contribute to the airtightness of the air duct system, if the fittings have sufficient airtightness in accordance with NEN-EN 1751.

3.2.6 Variable volume control

Function
A variable volume controller, VAV controller or VVC, is used in a ventilation system to measure and automatically control flow rates based on an external value, such as CO_2, temperature, presence, etc. When the measured value changes, the position of the valve blade is automatically adjusted so that the flow rate changes. Material quality and thicknesses For normal comfort ventilation, variable volume controls are manufactured from the following materials:

Material quality and thicknesses
For normal comfort ventilation, variable volume controllers are manufactured from the following materials:

- Casing: Sendzimir galvanised steel;;
- Valve blade: Sendzimir galvanised steel, with rubber sealing ring;
- Other choice of material, depending on the application, in consultation with the supplier.
- Connections
- The variable volume controller is available with circular and rectangular connections.

Dimensions
The available nominal dimensions of the intermediate variable volume controls are standardised according to NEN-EN 1505 (rectangular connections) and NEN- EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as referred to in this guide in sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Inspection possibilities
It should always be possible to inspect intermediate variable volume controls for operation and valve position (this can usually be checked from the outside).

Assembly instructions
Variable volume controls shall be installed in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.
A minimum distance from or to a bend, fan, valve, etc. must be taken into account. For circular measuring stations a minimum distance of 2 x the connection diameter is recommended. This distance differs per supplier. If there is no clear specification by the supplier, a minimum distance of 1 to 2 times the connection diameter is recommended for circular variable volume controls. For rectangular variable volume controls, a minimum distance of 1 to 3 times the duct width is recommended (depending on the desired measurement accuracy; the greater the distance, the higher the measurement accuracy).

Insulation
The housing of the variable volume control is also available with factory- soundproofing.

Sustainability aspects
Variable volume controls with circular connections can be efficiently connected to air ducts and contribute to the airtightness of the air duct system, if the fittings have sufficient airtightness in accordance with NEN-EN 1751.

The VAV principle is applied to save energy. The air volume, and thus the required energy consumption of the air handling system, is determined on the basis of the demand from the building or space.

3.2.7 Silencer

Function
A silencer is used in an air transport system to absorb and reduce installation noise so that permissible sound levels are not exceeded.

Material quality and thicknesses
For normal comfort ventilation, silencers are manufactured from the following materials:

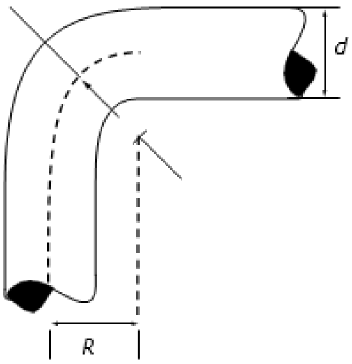
- Rigid silencers:
- Outer layer: Sendzimir galvanised steel;
- Inner layer: perforated Sendzimir-galvanised steel;
- Absorption/damping material: mineral wool, glass wool or polyester (usually 50 or 100 mm);

- Coulis (optional): finished mineral wool sheets to prevent the fibres from entering the air flow;
- Semi-flexible silencers:
- Aluminium flanged flexible pipe;
- Silencer in duct:
- Plastic, polystyrene foam;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The silencer is available with circular and rectangular connections.

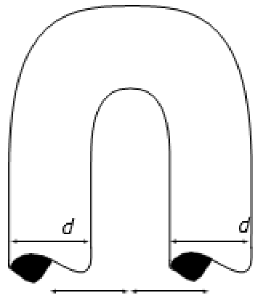
Dimensions
The available nominal dimensions of the intermediate built-in cilencers are standardised according to NEN-EN 1505 (rectangular connections) and NEN- EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as referred to in this guide in sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.
The length of a circular silencer depends on its function in the air duct system. The most common silencers are available in lengths of 300, 500, 600, 900, 1000 and 1200 mm.

Assembly instructions
Silencers must be fitted in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.



Assembly of semi-flexible silencers
A minimum bending radius results in a large pressure drop. Therefore the aim should be a bend as wide as possible with a straight inlet of 2 x the diameter (d). The aim should therefore be to achieve as wide a bend as possible. For semi-flexible dampers, a minimum bending radius of R= d + 2 x insulation thickness should be observed. Suppliers recommend a minimum bending radius of twice the diameter (d). Double bends should be avoided.

Insulation
Specifically in the case of fibrous material (internal insulation), seams and the like must be finished in such a way that the fibrous material cannot be carried away by the air current.



Sustainability aspects
Silencers with circular connections can be connected to the air ducts more efficiently than silencers with rectangular connections and contribute to the airtightness of the air duct system, if these fittings possess sufficient airtightness according to NEN-EN 15727.

Inspection possibilities
It must always be possible to inspect intermediate filter sections

3.2.8 Filter section

Function
A filter section, or filter box, is used in an air transport system to clean air and/or to keep it clean.

Material quality and thicknesses
For normal comfort ventilation, filter sections are manufactured from the following materials:

- Casing: Sendzimir galvanised steel;;
- Filter: compact, panel, or bag filter; available in different filter classes, such as G3, G4, M5, M6, F7, F8 and F9;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The filter section is available with circular and rectangular connections.

Dimensions
The available nominal dimensions of the intermediate filter sections are standardised according to NEN-EN 1505 (rectangular connections) and NEN-EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as referred to in this guide in sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer. Therefore, when installed, there must be a possibility to easily remove, check and replace the filter. To this end, the filter section must be equipped with a removable inspection cover. This cover is attached to the housing in an airtight manner.

Assembly instructions
Filter sections must be fitted in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.

Sustainability aspects
Filter sections with circular connections can be connected to the air ducts more efficiently than filter sections with rectangular connections and contribute to the airtightness of the air duct system, if these fittings possess sufficient airtightness in accordance with NEN-EN 15727.

3.2.9 Measuring station

Function
A measuring station, or measuring cross, is used in a ventilation system to measure the actual air volume.

Material quality and thicknesses
For normal comfort ventilation, measuring stations are manufactured from the following materials:

- Casing: Sendzimir galvanised steel;;
- Measuring points: Sendzimir galvanised steel or aluminium;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The measuring station is available with circular and rectangular connections.

Dimensions
The available nominal dimensions of the intermediate measuring stations are standardised according to NEN-EN 1505 (rectangular connections) and NEN- EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as referred to in this guide in sections 2.1.1.6 (rectangular connections) and 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Assembly instructions
Measuring stations must be fitted in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4. The measuring station should be mounted so that the arrow on the casing points in the air direction. This is very important for proper operation. A minimum distance from or to a bend, fan, valve, etc. must be taken into account. For circular measuring stations a minimum distance of 2 x the connection diameter is recommended. For rectangular constant volume controllers a distance of 2 x the duct width is recommended. For rectangular constant volume controllers, a minimum distance of 2 times the duct width is recommended.

Sustainability aspects
Measuring stations with rubber sealing rings can be efficiently connected to air ducts and contribute to the airtightness of the air duct system, if the fittings have sufficient airtightness in accordance with NEN-EN 15727.

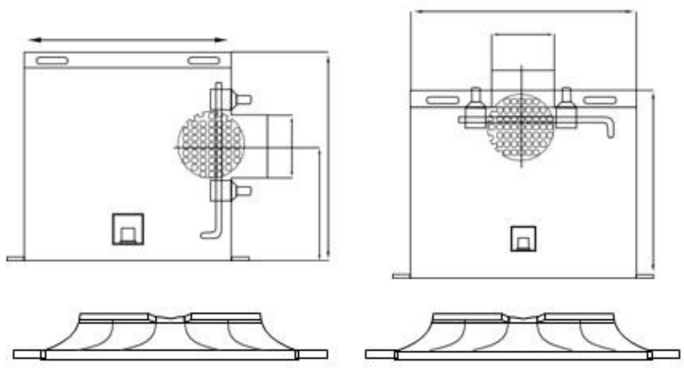
3.2.10 Vent plenum

Function
A vent plenum, or connection plenum, is used in an air transport system to connect a vent to an air duct. The pressure build-up within the plenum for the supply air vent also ensures an even air distribution and a correct operation of the vent.

Material quality and thicknesses
For normal comfort ventilation, vent plenums are manufactured from the following materials:

- Casing: Sendzimir galvanised steel, plastic or PIR/PUR sheets;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The vent plenum has a circular top or side connection, fitted with a rubber sealing ring for an air tight connection to the air duct system. To prevent leakage or damage, drilling, etc. should be avoided during installation.



Dimensions
The nominal connection diameters available for vent plenums are standardised to NEN-EN 1506 (circular connections) and can be selected as shown in the tables for standard dimensions given in this guide under section 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm .The dimensions of the vent plenum and the connection to the vent depend on the manufacture and the type and dimensions of the vent.

Inspection possibilities
To allow easy inspection of the vent plenum, front panels can be chosen to be removable or hinged.

Assembly instructions
The fitting is fitted with a push-fit flange, provided with a rubber sealing ring. The sliding part is pushed into the

spirally seamed pipe and fixed with rivets or self-drilling screws.
If no further specification of the ceiling structure is given in the specifications, a grid of 600 x 600 mm is assumed for the installation of the ceiling plenums.
Vents must be delivered per room where they are to be installed and provided with a code that corresponds to a location on the installation drawing.

The customer must ensure that the "technical ceiling tiles" are laid in the grid. So- called "technical ceiling tiles" are ceiling tiles (with or without back-planks) with recesses in accordance with the spacing of the relevant vent plenums. The air duct company mounts the tiles to the vents and places the tile with vent in the grid, at the location indicated on the installation drawing. Next, the vent is connected to the duct system with a flexible hose. To prevent contamination of the surrounding ceiling tiles, the described work must be carried out before the remaining ceiling tiles are installed. Where a vent is supplied with a 595 x 595 module board, the vent is laid directly into the 600 x 600 grid.

If the specifications state that the vents must be suspended, this is normally done by means of two quick release hangers (with a maximum length of 600 mm) from the ceiling above. If the suspended ceiling does not consist of a grid, but of interlocking boards, laminated board or plaster ceiling, the vents will have to be suspended from the ceiling above using quick hangers with a length of maximum 600 mm during the assembly of the ceilings. In connection with the planning and to avoid waiting times, this must be carried out by third parties.

Sustainability aspects
Vent plenums with circular connections, fitted with rubber sealing rings, can be connected efficiently to air ducts and contribute to the airtightness of the air duct system, if the fittings comply with the airtightness requirements in NEN- EN 15727.

3.2.11 Active chilled beam

Function
An active chilled beam, or induction unit, is used in an air transport system to ventilate, cool and possibly heat a room. The energy transfer to cool or heat the air in the unit takes place by means of water.

Material quality and thicknesses
For normal comfort ventilation, active chilled beams are manufactured from the following materials:

- Casing: Sendzimir galvanised steel;;
- Front sheet: Sendzimir galvanized steel;
- Plenum: Sendzimir galvanized steel;
- Cooling and heating element:
- Pipes: copper
- Slats: aluminium;
- Other choice of material, depending on the application, in consultation with the supplier.

Connections
The active chilled beam has a circular connection.

Dimensions
The nominal connection diameters available for active chilled beams are standardised to NEN-EN 1506 (circular connections) and can be selected as shown in the tables for standard dimensions given in this guide under section 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The available connection diameters depend on the manufacturer. The available dimensions depend on the manufacture. The width of an active chilled beam depends on the manufacturer. The most common units are available in lengths of 600, 1200, 1800, 2400 and 3000 mm.
The width of an active chilled beam depends on the manufacturer. The most common units are available in widths of 300 and 600 mm.

Inspection possibilities
It must always be possible to inspect intermediate active chilled beams for function and contamination. For this purpose, it must be possible to easily open or remove the front sheet.

Assembly instructions
Active chilled beams shall be installed in accordance with the manufacturer's instructions. If present, these should at least comply with the requirements in section 3.1.4.
There are various options for installing chilled beams, both freely suspended and built into a suspended ceiling. However, this is dependent on the manufacture and type. On the units, however, mounting possibilities must be provided to attach the box (using, for example, threaded rods) to the architectural ceiling above.

Internal cleanliness
It is recommended to install the active chilled beams that are equipped with removable front sheet and hinged battery.

Sustainability aspects
Active chilled beams with circular connections can be efficiently connected to air ducts and contribute to the airtightness of the air duct system, if the fittings have sufficient airtightness in accordance with NEN-EN 15727.
Active chilled beams contain no filters or moving parts. The units are therefore virtually maintenance free.
Active chilled beams also offer a number of advantages over all-air systems:

- The energy transfer to cool or heat the air in the unit takes place by means of water. Energy transport by means of water is more energy-efficient than all-air systems;
- Less primary air from the air handling unit is required, due to induction into the room and sucking in air from the room;
- The units are very suitable for the application of variable (VDV) or demand- dependent (DDV) ventilation. The VDV principle, and to an even greater extent the DDV principle, is used to save energy. The air volume, and thus the required energy consumption of the air handling system, is determined on the basis of the demand from the building or space. This is done on the basis of a measured value from the room, such as CO2, temperature, presence, etc.

3.2.13 Fire damper - circular

Function
A circular fire damper is used in an air duct to close off a circular air duct, thus preventing fire from spreading through the air duct. The fire damper contributes to the objective to prevent the propagation of fire to adjacent compartments for a certain period of time.

Material quality and thicknesses
For normal comfort ventilation, fire dampers are manufactured from the following materials:

- Casing: Sendzimir galvanised steel;;
- Valve blade: fire retardant and thermally insulating material.

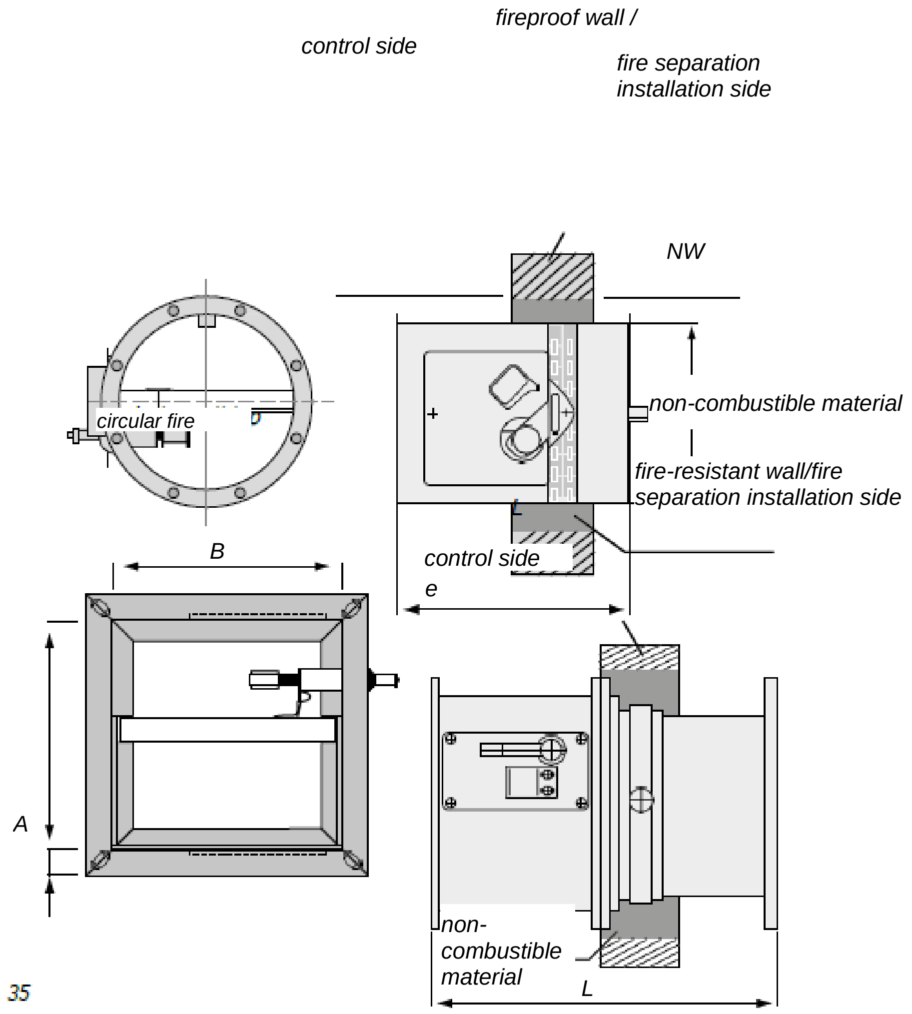
All fire dampers must have a CE marking and be classified according to EN 13501-3. Other choice of material, depending on the application, in consultation with the supplier.

Connections
The circular fire damper has circular connections, equipped with a rubber sealing ring for an airtight connection to the air duct system. To prevent leakage or damage, drilling, etc. should be avoided during installation.

Dimensions
The available nominal dimensions of the intermediate circular fire dampers are standardised to NEN-EN 1506 (circular connections) and can be selected as indicated in the tables for standard dimensions, as mentioned in this guide under chapter 2.1.3.6 (circular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Inspection possibilities
It should always be possible to inspect intermediate fire dampers for operation and valve position (this can usually be checked from the outside).

Assembly instructions
Circular fire dampers must be installed and sealed in accordance with the manufacturer's instructions. The type of wall/floor, the sealing and the type of fire damper determine the classification of the fire damper, including the number of minutes fire resistance. Sometimes it is not possible in construction to mount the fire damper partially in the fire separation. When the fire damper cannot be installed in the fire separating wall, the duct area between the fire separating wall and the fire damper needs to be insulated in such a way that the quality of the fire separation is maintained. This is carried out under responsibility of the building contractor.



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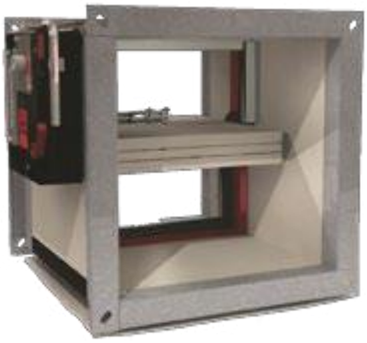
Insulation
The insulation must be installed in accordance with the manufacturer's instructions.

Sustainability aspects
Fire dampers with circular connections can be efficiently connected to air ducts and contribute to the airtightness of the air duct system, if the fittings have sufficient airtightness in accordance with NEN-EN 1751. Fire dampers that are fitted with a fire resistant surface-mounted clamp do not require additional sealing during installation. This reduces and simplifies the assembly time.

3.2.14 Fire damper - rectangular



Function
A rectangular fire damper is used in an air transport system to close off a rectangular air duct in order to prevent fire from spreading through the air transport system. The fire damper contributes to the objective to prevent the propagation of fire to adjacent compartments for a certain period of time.

Material quality and thicknesses
For normal comfort ventilation, fire dampers are manufactured from the following materials:

- Casing: Sendzimir galvanised steel or Promatect-H;
- Valve blade: fire retardant and thermally insulating material.

All fire dampers must have a CE marking and be classified according to EN 13501-3.
Other choice of material, depending on the application, in consultation with the supplier.

Connections
The rectangular fire damper has rectangular connections and must be provided with a flange edge according to NEN-EN 1505 or ISO 13351.

Dimensions
The available nominal sizes of the intermediate rectangular fire dampers are standardized according to NEN-EN 1505 (rectangular
connections and they can be chosen as shown in the tables for standard dimensions given in this guide in section 2.1.1.6 (rectangular connections). They refer to the internal dimensions with a tolerance of +0 to -5 mm. The dimensions depend on the manufacturer.

Inspection possibilities
It should always be possible to inspect intermediate fire dampers for operation and valve position (this can usually be checked from the outside).

Assembly instructions
Rectangular fire dampers must be installed and sealed in accordance with the manufacturer's instructions. The type of wall/floor, the sealing and the type of fire damper determine the classification of the fire damper, including the number of minutes fire resistance. Sometimes it is not possible in construction to mount the fire damper partially in the fire separation. When the fire damper cannot be installed in the fire separating wall, the duct area between the fire separating wall and the fire damper needs to be insulated in such a way that the quality of the fire separation is maintained. This is carried out under responsibility of the building contractor.

Insulation
The insulation must be installed in accordance with the manufacturer's instructions.

Sustainability aspects
Fire dampers can be connected to air ducts efficiently and make a contribution to the airtightness of the air duct system, if the fittings comply with the airtightness requirements in NEN-EN 1751. Fire dampers that are fitted with a fire resistant surface-mounted clamp do not require additional sealing during installation. This reduces and simplifies the assembly time.

3.2.15 Flexible hose

Function
A flexible hose is used in an air transport system to connect a vent, valve or vent plenum to an air duct.

Material quality and thicknesses
For normal comfort ventilation, flexible hoses are manufactured from the following materials:

Aluminium
Aluminium straps according to NEN-EN 573 are used for manufacturing aluminium flexible ducts. The thickness of the material depends on the type of hose and on the supplier. The minimum band thickness is 0.095 mm;
Aluminium foil
The hose is composed of layers of aluminium and polyester foil or aluminium polyester laminate in which a spiral wire is incorporated. The thickness of the material depends on the type of hose and on the supplier;

Plastic
The hose is manufactured from a fibre-reinforced synthetic cloth or from a vinyl-coated fabric cloth incorporating a spiral wire. The thickness of the material depends on the type of hose and on the supplier.

The spiral wire is made of steel; concealed or non-concealed, if necessary with a coating. Hoses are available in three versions:
- uninsulated;
- thermally insulated;
- acoustically insulated.

Fire resistance
If required, the fire resistance must be specified in accordance with the fire classifications in the NEN-EN 13501-1.

nominal diameter mm
63
80
100
125
150
160
200
250
300
315
355
400
450
500
560
630

Dimensions
The nominal sizes available for intermediate flexible hoses are standardized to NEN-EN 13180 and can be selected as shown in the table (see right). The dimensions depend on the manufacturer.
The flexible hoses are usually supplied in a compressed version. The hose must be stretched out before use. After stretching, the hose should be no more than 3% shorter than the nominal length specified by the supplier. The lengths available vary by manufacture and are available from 1 to 10 metres when extended. When compressed, the lengths are 0.4 to 3 metres, depending on the type and manufacture of the hose. A minimum of 0.5 to maximum 1.5 metres of hose to be used should be aimed for. If a longer length has to be used, the hose should be properly clamped.

Cutting uninsulated hoses:
- Stretch out the hose properly; a hose that is not fully extended leads to unnecessary pressure loss;
- Measure the correct length and mark this point with a felt-tip pen; never use more hose than absolutely necessary;
- Between the spiral windings, cut the material along the full circumference;
- Use a cutter to cut the spiral of the hose;
- Cut away the excess spiral.

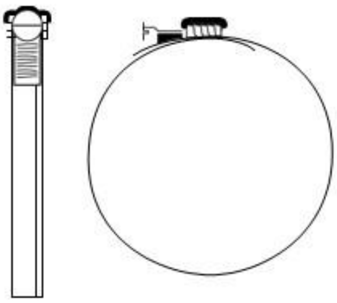
Cutting uninsulated hoses:

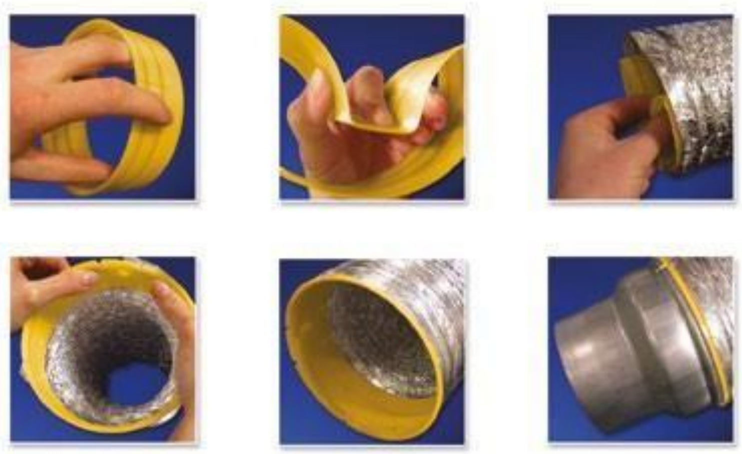
- Stretch out the hose properly; a hose that is not fully extended leads to unnecessary pressure loss;
- Measure the right length and mark this point with a felt-tip pen; never use
- more hose than absolutely necessary;
- Using a sharp knife, cut through the outer layer, insulation material and inner hose;
- Cut the hose along its full circumference and use a cutter tocut the spiral of the inner hose;
- Cut away the excess spiral;
- Use scissors to remove any excess insulation material.

Assembly instructions

Installation of uninsulated hoses:

- Shorten the hose appropriately;
- Slide the hose at least 40 millimetres over the connection;
- Then secure the hose with a sturdy hose clamp or by using a tie-wrap which should be tightened with matching pliers and prescribed pre-tension;
- The hose may also be mounted using a so-called "guso" ring. However, this should be done according to the suppliers' installation instructions.

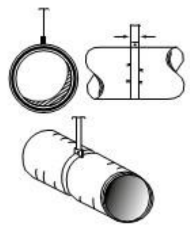


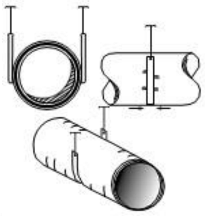


Installation of insulated hoses:

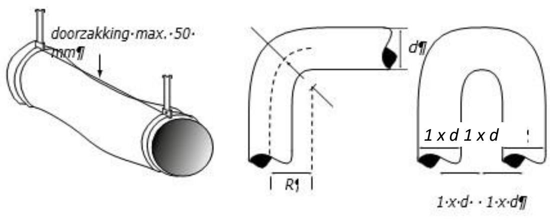
Shorten the hose appropriately;

- Push the insulation material and the outer casing back a little and tape the outer casing, including the insulation material, firmly and airtight to the inner hose;
- Push the hose at least 40 millimetres over the connection;
- Preferably use tape with a width of at least 50 mm;
- Clamp the outer casing with the inner hose to the connector using a sturdy hose clamp or by using a tie-wrap which should be tightened with the appopriate pliers, and prescribed preload;
- Use aluminium tape for pure aluminium and aluminium foil hoses and use plastic tape for plastic hoses;
- The hose may also be mounted using a so-called "guso” ring.This should be done according to the installation instructions of the suppliers.





sagging max. 50 mm



Suspension points:

- The maximum permissible sagging the hose, between two fixing points, shall not exceed 50 mm (measured at the centre);
- The distance between two suspension points can vary between 1.5 and 3 metres. This size depends on the type of hose that is used.

Braces:

A hose is generally very flexible and can be deformed quite easily. Deformation reduces the internal diameter and increases the pressure loss. Therefore, when bracing (e.g. by perforated band) make sure that the hose is not reduced in diameter. Also support the hose at least over half its circumference.

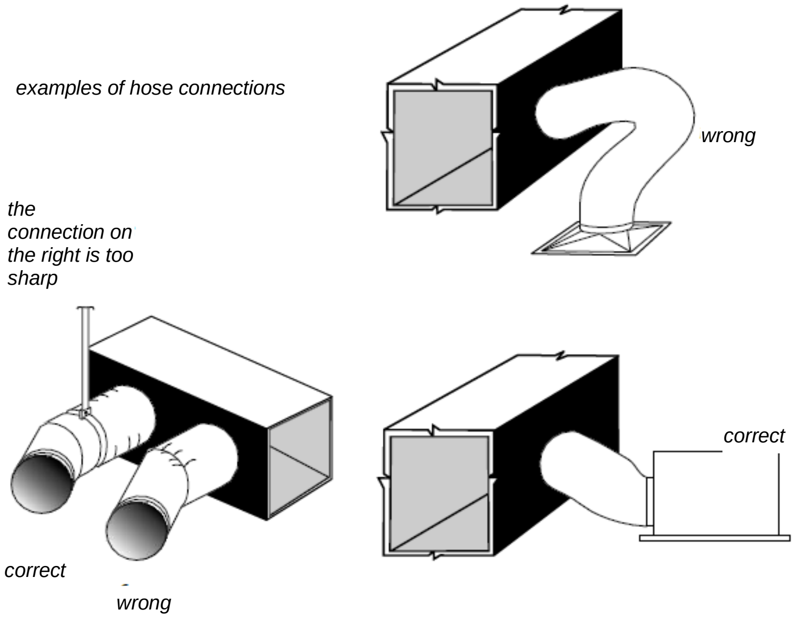
Bends:

According to NEN-EN 13180 the bending radius of a flexible duct must comply with R = d. However, this minimum bending radius results in a large pressure drop. The aim should therefore be to achieve as wide a bend as possible. For flexible hoses, a minimum bending radius of R= d + 2 x insulation thickness should be observed.

Manufacturers recommend a minimum bending radius of two times the diameter (d). Double bends should be avoided.

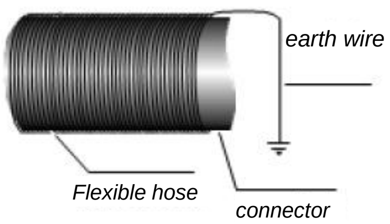
Connection to ducts and fittings:

The connection of flexible hoses to ducts and components must be made with due care. If hoses are installed in a sharp bend immediately after connection to the duct or fixture, a supporting bracket must be installed. Flexible hoses can break if duct connection is too "sharp". When connecting to a light fitting or air component, the most "direct" connection possible should be made, taking into account what has been described above. Too many bends in the hose increase the pressure loss unnecessarily and can cause noise. A minimum bending radius results in a large pressure drop. Therefore the aim should be a bend as wide as possible with a straight inlet of 2 x the diameter (d). For flexible hoses, a minimum bending radius of R = d + 2 x insulation thickness should be used. For flexible hoses, a minimum bending radius of R= d + 2 x insulation thickness should be observed. Suppliers recommend a minimum bending radius of twice the diameter. Double bends should be avoided.



Static electricity*:*

In a number of situations, especially with plastic hoses, the build-up and discharge of static electricity can cause an explosion hazard. By connecting the spiral wire of the flexible hose to an earth wire, the build-up of static electricity can be minimised. This work is carried out by third parties.



Insulation
Thermally insulated hoses have an inner hose similar to described uninsulated hoses. The hose is wrapped with a thermally insulating material like glass wool or rockwool. Around the insulation an outer cover of reinforced aluminium polyester laminate is applied, possibly with a steel spiral.
Acoustically insulated hoses have a spirally reinforced inner hose of glass fibre mesh, wrapped with an acoustic material such as glass wool or rock wool. Around the insulation an outer layer is placed of reinforced aluminium laminate or plastic foil, possibly with a steel spiral. Between the inner pipe and the insulation a foil layer can optionally be applied which prevents particles of the insulation from entering the duct.

Airtightness
The air leakage occurring in the air transport route must be limited in order to minimise the energy consumption of the air-conditioning installation. Unless stated otherwise in the specifications, Luka uses class C as the airtightness requirement. Flexible hoses therefore have to meet at least airtightness class C according to NEN-EN 13180.

Sustainability aspects
Stretch the hose out completely before assembly; an incompletely stretched hose leads to unnecessary pressure loss and thus higher energy consumption of the air handling unit.

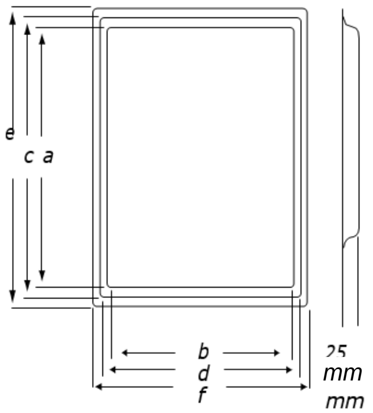
3.2.16. Inspection hatch

Function
An inspection hatch, or inspection cover, is used in an air transport system for easy access to and monitoring of contamination in a circular or rectangular duct.

Material quality and thicknesses
For normal comfort ventilation, inspection hatches are manufactured from the materials from which the air ducts are made. An exception to this are mineral wool and hard foam ducts, where metal hatches may be used. Other choice of material, depending on the application, in consultation with the supplier.

Connections
The inspection hatch is available for circular and rectangular ducts and is equipped with a rubber seal on the inner part for an air tight connection to the air duct system.

Dimensions
The dimensions depend on the manufacture and can be chosen as an example as indicated in the following table for standard dimensions. The nominal sizes of the inspection doors have a tolerance of +0 to -5 mm.



inspection cover	number of clasps	a	b	c	d	e	f
IDE 1	2	205 mm	115 mm	237 mm	147 mm	281 mm	191 mm
IDE 2	2	330 mm	195 mm	367 mm	232 mm	414 mm	297 mm
IDE 3	4	460 mm	320 mm	500 mm	360 mm	552 mm	412 mm
IDE 4	4	610 mm	462 mm	653 mm	502 mm	705 mm	550 mm

Inspection possibilities
It must always be possible to remove and replace installed inspection hatches.
In order to be able to inspect the installation properly, a sufficient number of inspection hatches are required. The hatches should be fitted in the right place and be of sufficient size. Components with inspection hatches are preferred. In addition to the hatches for components requiring service which are not fitted with an inspection hatch, it is recommended that additional hatches are fitted in shafts, technical rooms and floors. The hatches must be easily accessible and be clearly indicated by the coordinating party on the drawing. NEN-EN 12097 should preferably be used as the basis for the inspection facilities.

Assembly instructions
Inspection hatches should be fitted in accordance with the manufacturer's instructions.

Non-insulated inspection hatches
Uninsulated inspection hatches can be built in or constructed on both circular and rectangular ducts. After carefully making the correct cut in the duct, the inspection cover should be fitted in accordance with the manufacturer's instructions.

Insulated inspection hatches
Insulated inspection covers are normally fitted to insulated ducts. After carefully making the correct cut in the duct, a sealant should be applied to the underside of the frame of the inspection cover before fitting it to the previously made cut. The fixing of the frame to the sheet metal duct wall is preferably done using pop rivets or self-drilling parkers. Thereafter the insulation is finished to the frame of the inspection cover by means of aluminium tape.

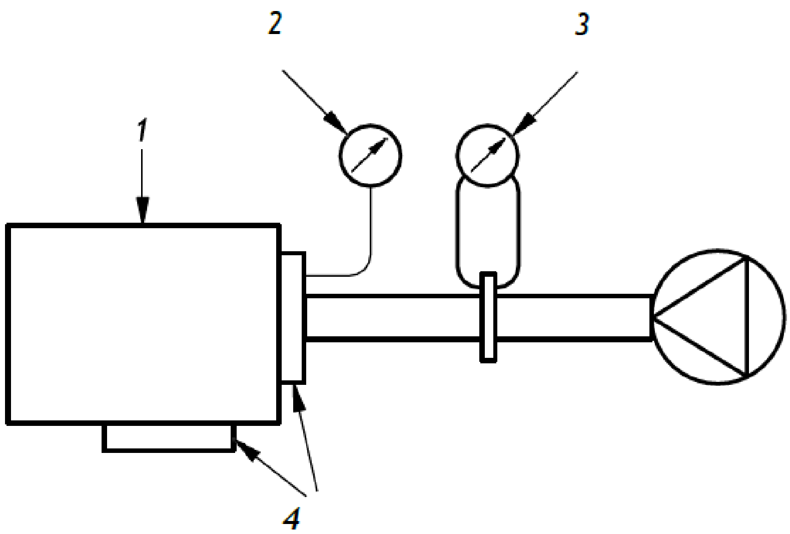
Internal cleanliness
It is recommended to protect the fittings from contamination. If the hatches are packed cleanly and properly and are only removed from the packaging when they are actually connected to the air duct system, the degree of contamination is minimised.

Sustainability aspects
Inspection hatches fitted with a rubber seal on the internal part provide an airtight connection to the air duct system and contribute to the airtightness of the air duct system, if the fittings are sufficiently airtight in accordance with NEN-EN 15727.

3.3 Airtightness of fittings

3.3.1 Measurement method for air leakage from fittings

In order to be able to assess whether a fitting meets the airtightness requirement, measurements must be taken. The principle of measurement is basically the same as for measurements on air ducts. A standard test rig is required for measurements on the single fittings. This test setup looks like the one shown next to the text. For the Luka Quality Certificate Luka members require measurement reports from suppliers of fittings or information through the Luka Fitting Register, the "LAR", to be able to assess whether the projected fittings satisfy the airtightness requirement imposed. Measurements must have been carried out by a measurement institute with a quality system according to ISO 17025. The international or national accreditation body of this measurement institute must be recognized and affiliated to the EA or MLA.
Please refer to the website of the Dutch Accreditation Council (www.rva.nl/search) for more information on accreditation. The Luka members also accept their own measurement reports from suppliers of fittings, provided these suppliers have a valid TÜV Rheinland Measuring Label.



There are three European standards that deal with measuring airtightness for fittings:

- NEN-EN 1751; applicable to valve registers and control and/or shut-off valves
- EN-EN 13180; applicable to flexible hoses
- NEN-EN 15727; applicable to other fittings (only measured on overpressure)

3.3.2 Rectangular fittings

To determine the permissible air leakage of valve registers, an equivalent length of 1 metre is specified for the length of these fittings, if the actual length is less than or equal to 1 metre.
For practical reasons Luka has agreed with suppliers and manufacturers to use this equivalent length for all rectangular fittings. This to the extent that the technical execution allows it and the actual length is smaller than 1 metre.

The formula for maximum air leakage for rectangular fittings is:øL/app = f.Ps 0,65.(2H + 2B).L where
øL/app = maximum amount of air leakage in l/s f = leakage factor
Ps = static pressure Pa
W = width of the component in metres
H = height of the component in metres
L = length of the component in metres, L = 1 if the length of the fitting is less than 1 metre or the actual length if the length is more than 1 metre.

3.3.3 Circular fittings

For practical reasons Luka has agreed with suppliers or manufacturers to use the equivalent length of 1 metre

for all circular fittings as well. This to the extent that the technical execution allows it and the actual length is smaller than 1 metre.
The formula for the maximum amount of air leakage for each round fitting that meets airtightness class C is: øL/app = f.Ps .0,65(π x D).L Where: D = diameter in metres

3.3.4 Flexible hoses

The determination of the airtightness of flexible hoses is described in the NEN-EN 13810.
The formula for maximum air leakage for flexible hoses is: øL/app = f.Ps 0,65. (π.dn.L) Where:
øL/app = maximum amount of air leakage in l/s
f = leakage factor
Ps = static pressure Pa
dn = nominal diameter in metres
L = length of component in metres (minimum length of hose according to NEN-EN 13180).

3.3.5 Classes of airtightness

The permissible amount of air leakage is related to classes of airtightness, for which a test pressure applies, which is taken from NEN-EN 1751, NEN-EN 13180 and NEN-EN 15727. Each type of fitting has its own respective standard, which can be found in the legend of the LAR at https://www.luka.nl/lar-luka-appendage-register/

Fittings only need to be tested for overpressure.

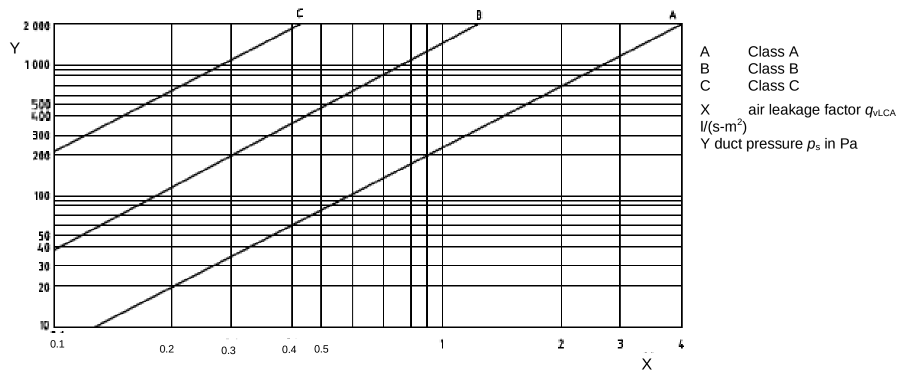


Figure taken from NEN-EN1751 (2014): graphical representation of the limiting values for airtightness classes

A report of the measurement, including a graphic representation of the airtightness with respect to the standardised classes must be submitted to the CET for approval via the secretariat. Only fittings that satisfy at least class C can be included in the LAR. An example of such a report/certificate can be found in paragraph 3.3.6.
The minimum number of measuring points and corresponding test pressures for each type of fitting are described in the sections below.

3.3.6 Component according to standard NEN-EN 1751 (2014):

Measured at a minimum of three (3) test pressures, namely:

test prints	Circular fittings*	Rectangular fittings **
1	+ 400 Pa	+ 400 Pa
2	+ 1000 Pa	+ 500 Pa
3	+ 2000 Pa	+ 1000 Pa

3.3.7 Component according to standard NEN-EN 15727 (2010):

Measured at a minimum of three (3) test pressures, namely:

test prints	Circular fittings*	Rectangular fittings **
1	+ 400 Pa	+ 400 Pa
2	+1000 Pa	+ 500 Pa
3	+ 2000 Pa	+1000 Pa

3.3.8 Component according to standard NEN-EN 13180 (2002)::

Test pressure to be measured is + 1000 Pa.
* A fitting is considered circular if the cross-section (flow area) is circular.
** A fitting whose cross-section (flow area) is rectangular shall remain as such whether or not it is provided with a circular connection(s) for connection to the duct.

3.3.9 Calculation example of the permissible air leakage loss

For a fire damper 600 x 600 mm with L = 500 mm.
Ps = 1000 Pa f = 0.003
øL/app = 0.003 x 1000 0.65 x (2x 0.60 + 2x 0.60) x 1 = 0.641 l/s
This fire damper may therefore leak a maximum of 0.641 l/s into the surrounding area at 1000 Pa in order to comply with airtightness class C. Based on the formula above, the maximum permissible leakage for a fitting (with a length of less than 1 m) in airtightness class C at the following pressures can be calculated as follows: 500 Pa øL/app = 0.17 x (2H + 2B) or 0.17 x (π x D) 1000 Pa øL/app = 0.267 x (2H + 2B) or 0.267 x (π x D)

EN 1751 Test Report Casing Air Leakage Rate

Date: **Test Reference Number:**

Place: **Tested by:** **Witness by:** **MR/vs....**

Model (name/type): **Result:** **Class A**

Air temperature (ºC)	20
Atmospheric pressure (Pa)	100000
Correction factor	0.987
Case width (m)	
Case Height (m)	
Duct Length (m)	
Other	

Pressure time	60 **sec.**	(standard)
Surface Area:	1.14	m^2

Measuring Equipment:

Air leakage tester type:

Serial No:

Date certification:

Calibration cert.no.

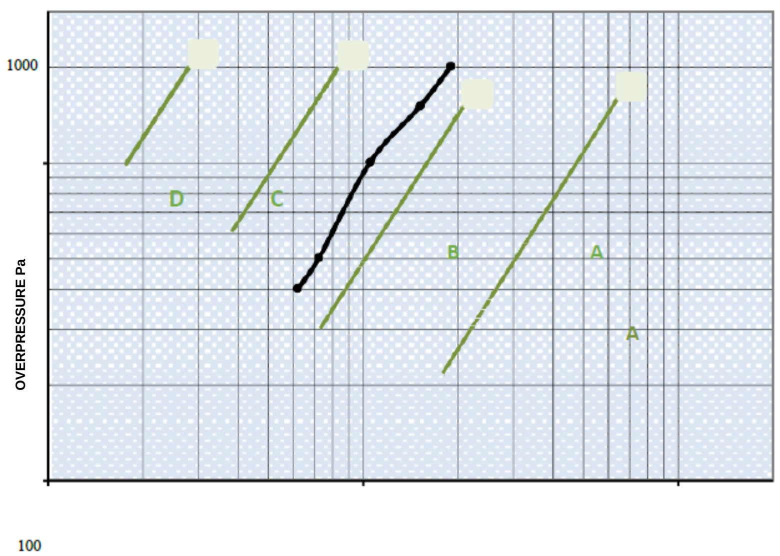
Reading	Static Pressure (Pa)	Leakage (N l/s)	Rig Leakage (l/s)	Leakage Duct Surface ($l/s/m^2$)	Corrected	Approximate EN 1751 Class A ($l/s/m^2$)	EN 1751 Class B ($l/s/m^2$)	EN 1751 Class C ($l/s/m^2$)	EN 1751 Class D ($l/s/m^2$)
1	**400**	**1.02**	**0.66**	**0.316**	**0.312**	**1.326**	**0.442**	**-**	**-**
2	**500**	**1.18**	**0.76**	**0.368**	**0.364**	**1.530**	**0.511**	**-**	**-**
3	**1000**	**1.79**	**1.18**	**0.535**	**0.528**	**-**	**0.802**	**0.267**	**0.089**
4	**1500**	**2.39**	**1.51**	**0.772**	**0.762**	**-**	**-**	**0.348**	**0.116**
5	**2000**	**3.03**	**1.93**	**0.965**	**0.952**	**-**	**-**	**0.420**	**0.140**

Picture component

From DW/144

Duct Pressure Class	Static Pressure limit Positive	Negative	Maximum Air Velocity	Air leakage limits litres per second per square metre of duct surface area
1	2	3	4	5
	Pa	Pa	m/s	l/s/m2
Low - Class A	500	500	10	0.027 x $p^{0.65}$
Medium - Class B	1000	750	20	0.009 x $p^{0.65}$
High - Class C	2000	750	40	0.003 x $p^{0.65}$

Medium - Class B 10 0.027 x $p^{0.65}$



LEAKAGE l/s/m2

EN 1751 Figure C.2 - Classification of Case Leakage

0.05 **0.50** **5.00**

Picture from test

Visual deformation?	No
@ Pa:	X

Approved and certified by Certificate no.:

4. Quality aspects

4.1 Quality control

Luka's quality policy is the most important part of the association's policy. Customers and clients can make high demands on the security that Luka members offer with regard to quality, reliability of delivery and compliance with specifications. Luka members are aware that quality is in the functioning of the organisation; quality problems often have an organisational cause. In order to meet the quality requirements, Luka members must say what they do and do what they say. And make this verifiable. Luka members have a quality system in accordance with, or derived from, ISO 9000. Luka members give their staff the opportunity to acquire skills through competence courses, safety courses, etc. All of this forms the basis for independent quality control by TÜV Rheinland Nederland B.V., who carry out the inspection and are responsible for the airtightness measurements carried out by the Luka members themselves. TÜV Rheinland Nederland B.V. carries out quality inspections based on a list of checkpoints drawn up on the basis of the quality standards, as laid down in this Quality Guide.
Through regular inspections of the delivered and installed products by TÜV Rheinland Nederland B.V., it can be determined whether the Luka member meets the quality standards set out in this Quality Guide. Based on this inspection, TÜV Rheinland Nederland B.V. confirms the Luka member's quality guarantee annually by means of a "Product Label" (see page 147). Through regular monitoring by TÜV Rheinland Netherlands B.V. on the products delivered and assembled, it can be determined whether the Luka member meets the quality standards set out in this Quality Guide. Based on this inspection, TÜV Rheinland Nederland B.V. confirms the Luka member's quality assurance annually by means of a "Product Label Certificate" (see page 133).

Associated members of Luka who produce and/or supply fittings and wish to carry out their own airtightness measurements also have the option of having their measurements checked annually by TÜV Rheinland Nederland B.V.. The correctness is guaranteed by means of a "Measuring Label (see page 134).

4.2 Quality guarantee

The technical execution of the air ducts, as laid down in the chapter " Quality Standards for air ducts", is guaranteed by internal and external controls. In practice, air ducts are often part of a complete pipeline network, for which only limited space is available. The design department and work preparation of every Luka-member are able to make coordinated working drawings with the client that, attuned to the production possibilities, guarantee an integrated duct system. Apart from employing skilled personnel, an optimal and constant quality of the manufactured air ducts is achieved by using modern computer-controlled production equipment.

Each discipline involved in the production process shall closely monitor the constant execution of the work in accordance with the quality standards. If the assembly of the air ducts is also done by the Luka member, the latter ensures that it is done by competent personnel, in accordance with the assembly requirements or assembly instructions set out in the Luka quality standards. The Luka member's installation inspectors regularly visit the projects to check compliance with these requirements and to prevent or manage deviations from the coordinated planning. The Luka member has designed its organization in such a way that it acts in the spirit of the Dutch standard for quality assurance (ISO 9000). In addition, an external check on the quality of the product is carried out by independent quality officials of TÜV Rheinland Nederland B.V. at regular intervals. Non-compliance with these standards is subject to sanctions.
In case a company wants to join the Dutch Association of Air Duct Manufacturers (Luka), balloting takes place based on the solvability and identity of the company's organization. It is also examined whether the member to be admitted is capable, in terms of company equipment, to continue to meet the Luka quality standards. In short: Luka members, each at their own level of size, are reliable construction partners who guarantee the consistent high-quality execution of projects. External Quality Control TÜV Rheinland Nederland B.V.

4.3 External Quality Control TÜV Rheinland Nederland B.V.

To ensure that the duct manufacturer actually produces and/or assembles in accordance with Luka quality standards, the association has entered into an agreement with TÜV Certification which, through independent external audits by TÜV Rheinland Nederland B.V., guarantees the applied performance of the ductwork. Quality officers from TÜV Rheinland Nederland B.V. regularly monitor compliance with standards. If Luka members fail to meet quality standards, sanctions may come into effect which are included in the contract and to which Luka members have unconditionally agreed. Through constant monitoring by TÜV Rheinland Nederland B.V., Luka is able to issue a "Quality Certificate" for projects carried out by Luka members (see annex). But the cooperation between the Luka association and TÜV Rheinland Nederland B.V. extends further. If technical issues arise, Luka can make use of the technical knowledge, experience, measuring equipment and laboratories of TÜV Rheinland Nederland B.V. to address the subject by means of theoretical approach or practical testing. Representatives of TÜV Rheinland Nederland B.V. regularly visit the meetings of the "Environment and Technology Committee" (CMT) and assist this committee with advice and assistance.

4.4. Specification airtightness

Luka recommends the following specification:
" Delivery and assembly in accordance with the Luka Quality Guide (latest version) with presentation of a valid Luka Quality Certificate "

a If requirements are imposed on the air transport route (including fittings), the delivery and assembly of the air ducts, incl. fittings, must be carried out in accordance with the quality standards as laid down in the Luka Quality Guide (latest version), where airtightness class "C" must be complied with as standard, according to the latest version of the LUKA Quality Guide.

Registration on the certificate:

The production, assembly and mounting of the air transport systems, including fittings, have been carried out according to the most recent Luka Quality Guide.
and

a) If requirements are imposed on the air transport route (excluding fittings), the delivery and installation of the air ducts shall be carried out in accordance with the quality standards as laid down in the Luka Quality Guide (latest version), where airtightness class "ATC 3" shall be complied with as standard, according to the latest version of the LUKA Quality Guide.

Registration on the certificate:

The production and assembly of the air ducts has been carried out according to the most recent Luka Quality Guide*.

In both cases, airtightness should be checked and demonstrated by issuing a "Luka Quality Certificate".

* most recent Luka Quality Guide at the time of commissioning.

5. Environmental policy

Sustainability and Corporate Social Responsibility. Luka and its members regard the environmental policy as an integral part of the total policy to be pursued, which is aimed at a continuous improvement of the environmental performance. In that respect the association and its members shall make an effort to prevent or limit the negative environmental effects its activities (can) cause as much as possible. The environmental impacts are sought to be kept as low as possible by taking preventive measures or mitigation measures, both organisational and technical.

The association and its members endeavour to:

- Make responsible use of the necessary raw materials and auxiliary materials;
- Where possible, choose alternative materials with less environmentally damaging properties or production methods;
- In the business processes preceding the realisation, reduce CO_2 as much as possible;
- Reduce the energy consumption of the air transport system by continuously improving the airtightness.
- Reduce the energy consumption of the air transport system by continuously improving airtightness.

In order to effectively and purposefully implement the environmental policy, the association applies the following principles:

- The members support the environmental policy and are aware of their responsibility in realizing them;
- The stimulation of environmentally conscious thinking and acting among the members;
- Compliance with the applicable laws and regulations.
- Because of a pro-active attitude towards environmental laws and regulations and the goals Luka set for itself, this process is stimulated by the CET, Luka's Committee Environment and Technology.

6. Risk

6.1 General

Luka members in principle, when accepting orders for supply and installation of air duct systems, apply the "Joint Contract Terms and Conditions Installers/Luka VLA." (G.C.I.). Article 4.1 of these terms and conditions states that, unless otherwise stated, the agreed price is fixed and binding. If, however, increases in price-determining factors have been contractually laid down, Luka members shall apply the risk regulation set out below.

Arrangements for offsetting of changes in wage costs and material prices:

1. The contractor shall be entitled to change the price agreed when the order was placed if one or more of the cost price factors changes after the date of the offer.
2. The contractor shall provide the client with a statement of the relevant price factors, which are, as a rule: the wage factor (L) and/or the material factor (M)(L. %: M. %).
3. Offsetting payroll changes shall be accomplished by periodic determination of the percentage change, as follows:

$$\frac{L2-L1}{L1} \; 100\% = . \quad \%$$

L1 is the wage level on the offer date, L2 the wage level on the change date. The wage level on the respective dates will be the Norm Wage VNG per hour as published by VNG.

4. The offsetting of material price changes takes place on the basis of index figures of the VNG. The percentage of change is determined as follows:

$$\frac{M2-M1}{M1} \; 100\% = . \quad \%$$

M1 is the VNG price index (published as above) at the date of offer, and M2 the VNG price index at the date of change.

5. Each instalment invoice of the contract sum issued by the Contractor shall be adjusted by the modified cost price factors (in the percentages indicated under 3 and 4). The percentage shall be determined according to the standards and index values applicable on the date of the instalment invoice concerned. Offsetting of partial invoices will not take place.

Risk regulation

If the G.C.I. is not applicable, Luka members, when accepting orders for the delivery and installation of air duct systems, in principle apply delivery and payment conditions, which correspond to the conditions, issued by the Metaalunie (Dutch organisation of entrepreneurs in the small and medium-sized metal industry).
If price increases are passed on, contrary to what is stated in these conditions, the above risk regulation shall also apply.

6.2 Measurement methodology

The Dutch Association of Manufacturers of Air Ducts (Luka) considers it essential to define uniform principles when determining the surface area of rectangular air ducts, circular air ducts and fittings.

To this end, formulas have been devised for the most common components, with which the quantity is calculated. For rectangular ducts and circular ducts larger than 315 mm, so called 'large round' and for fittings the unit of quantity is m2 duct area.

For circular air ducts with a diameter of up to 315 mm, so-called 'small round', this is the length of the duct. The quantity obtained from calculations may be used for offsetting. The bases for the formulas are based on the calculation methods used by Luka members and thus on practice.

For rectangular air ducts and 'large round' applies:

- To calculate the duct area of any duct piece, the largest circumference of the duct opening and the length of the duct piece, both expressed in metres (m1), are decisive. The length of the various duct pieces is defined as shown on the accompanying drawings;
- No deduction will be made for any cuts made in the duct surface for any purpose;
- Baffles, covers, etc., attached in or to the duct piece shall be added to the quantity in proportion to their functional area;
- For the calculation of the quantity of internal insulation of straight ducts, expressed in m2, the duct area applies.

For 'small round' applies:

- The length of the duct is determined by measuring over the centre line with measurement over valves and fittings. For 90° bends and branches the length is defined as shown in the accompanying drawing.

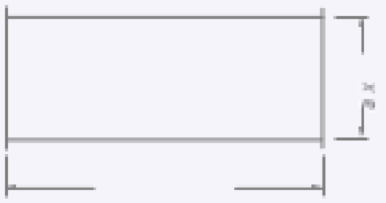
The same principles are used to determine the surface area of the duct for the airtightness test, with the understanding that in the case of 'small round' the calculated length is multiplied by the circumference. The same principles are used to calculate the quantity of external insulation, expressed in m2, with the understanding that the thickness of the insulation is taken into account in determining the circumference.

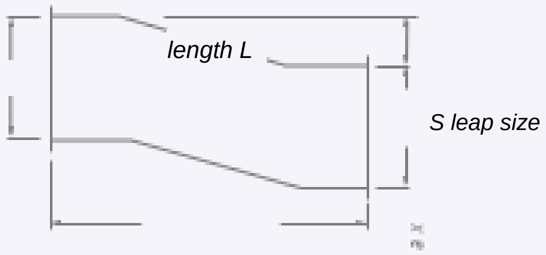
surface determination of rectangular air ducts

duct area

k

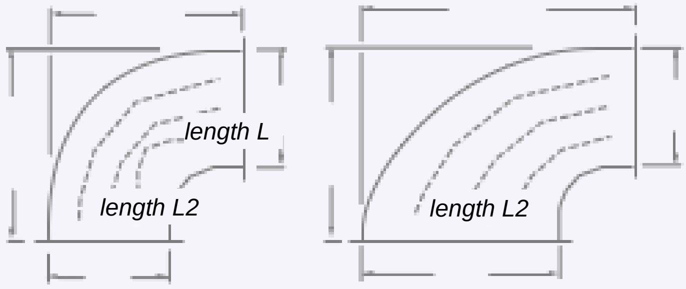
= 2 (a + b) x L





duct area

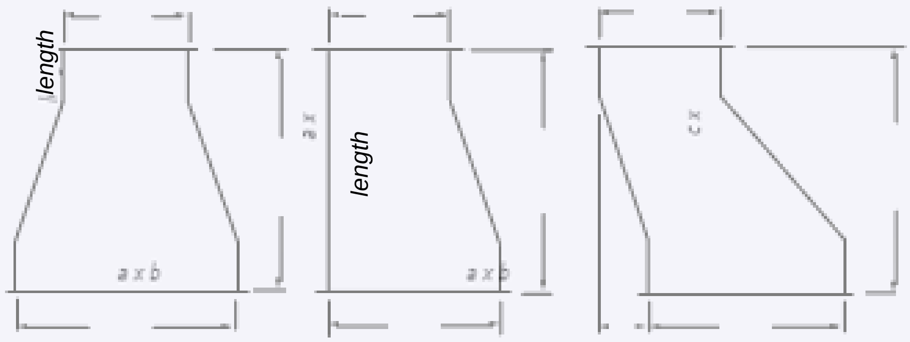
= 2 (a + b) x (L + S)



duct area

= 2 (a + b) x (L1 + L2)

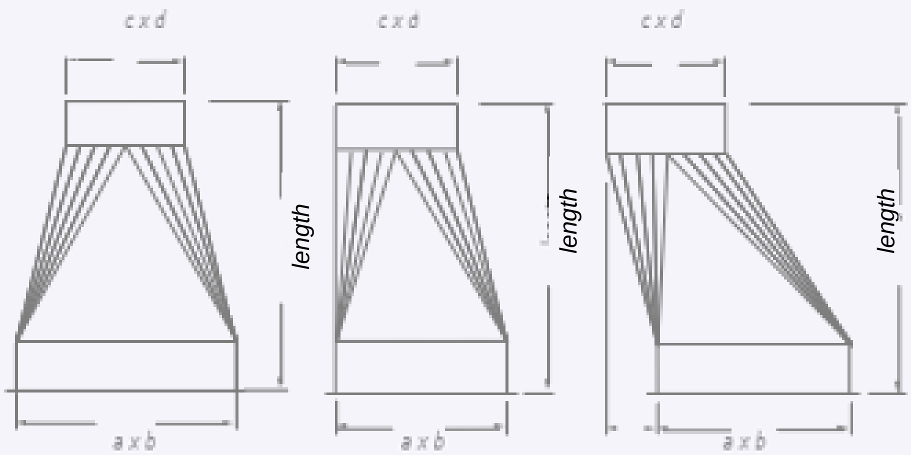
including guide blades



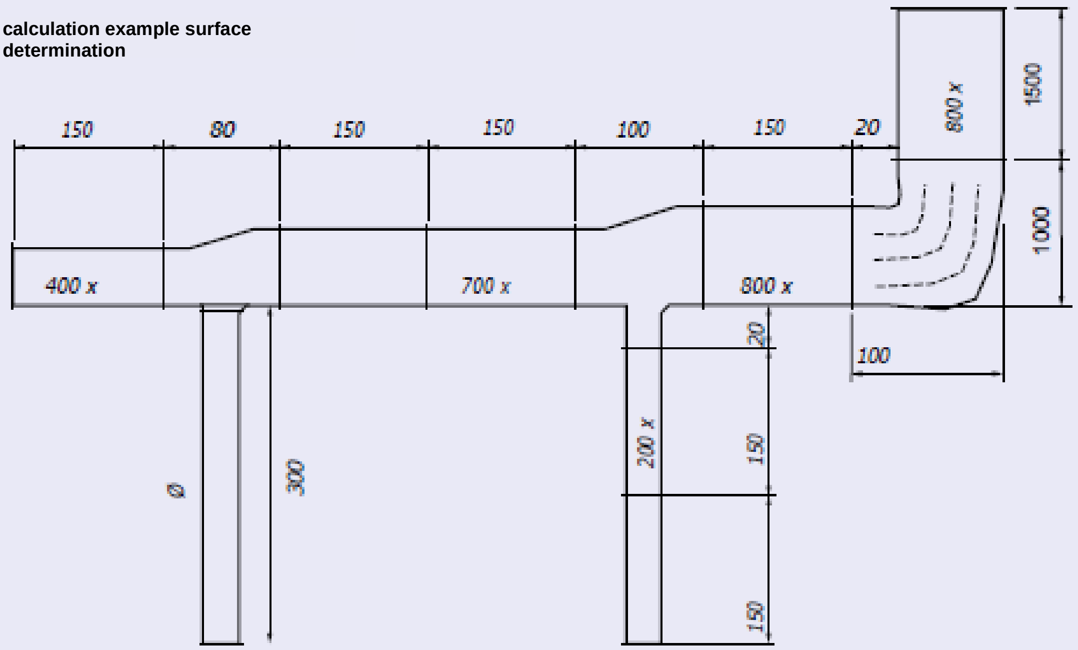
duct area

k

= 2 (a + b) x (L + S)



calculation example surface determination

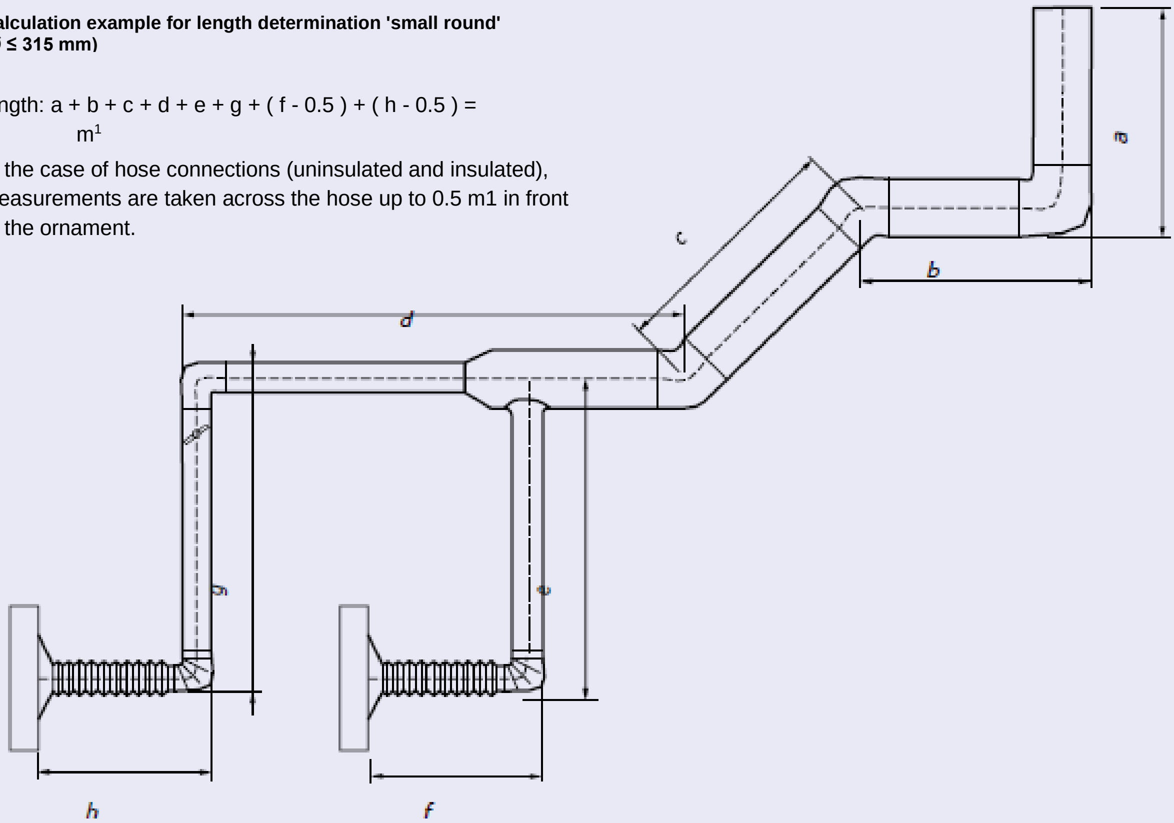


800	x	400	1,5 + 1,0 + 1,0 + 1,5 + 1,0	=	6.0 x 2.4	=	14.4	m^2
700	x	400	1.5 + 1.5 + 0.8	=	3.8 x 2.2	=	8.4	m^2
400	x	400	1.5	=	1.5 x 1.6	=	2.4	m^2
200	x	400	0.2 + 1.5 + 1.5	=	3.2 x 1.2	=	3.84	m^2
Ø 315			*3*	=	*3 x 0.315 x* π	=	2.97	m^2
					duct area		32.01	m_2

Calculation example for length determination 'small round' (Ø ≤ 315 mm)

length: a + b + c + d + e + g + (f - 0.5) + (h - 0.5) = m[1]

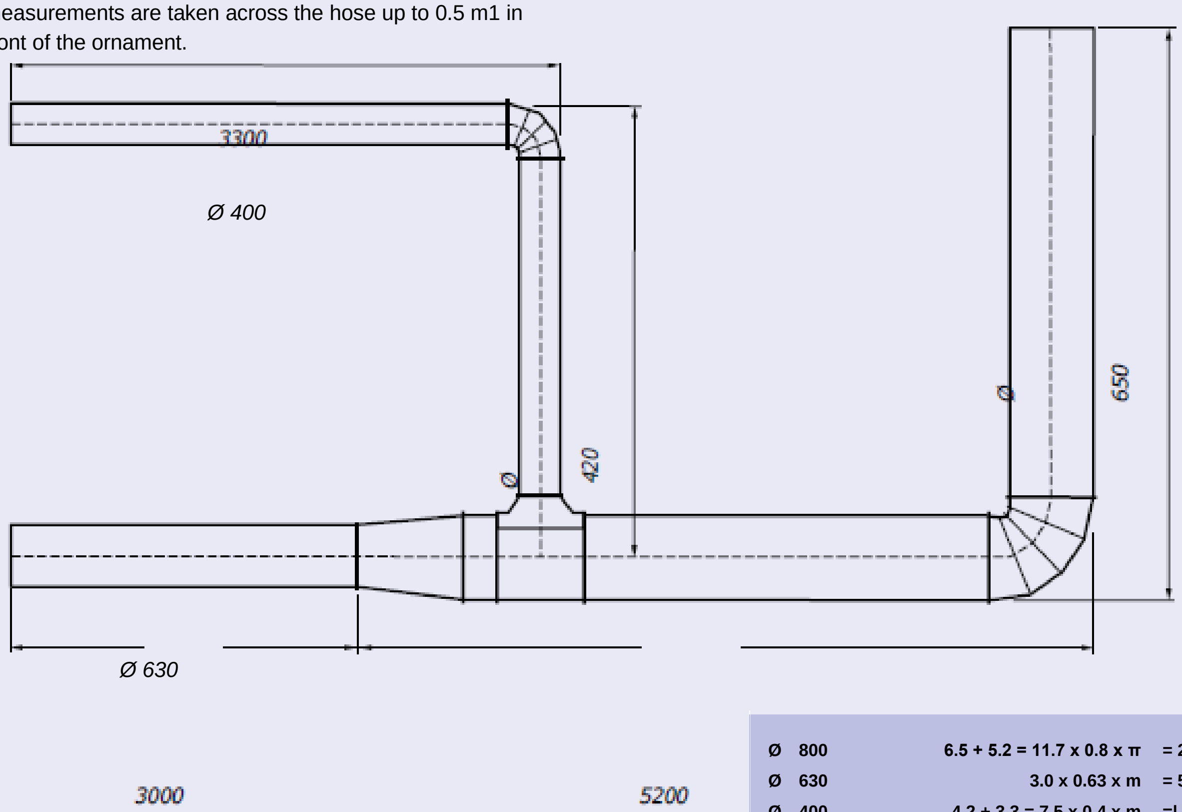
In the case of hose connections (uninsulated and insulated), measurements are taken across the hose up to 0.5 m1 in front of the ornament.



calculation example for surface determination 'large round' (Ø > 315 mm)

length: a + b + c + d + e + g + (f - 0.5) + (h - 0.5) = m[1]

In the case of hose connections (uninsulated and insulated), measurements are taken across the hose up to 0.5 m1 in front of the ornament.



Ø	800	6.5 + 5.2 = 11.7 x 0.8 x π	= 29.4	m²
Ø	630	3.0 x 0.63 x m	= 5.9	m²
Ø	400	4.2 + 3.3 = 7.5 x 0.4 x m	=| 9.4	m²
		duct area:	44.7	m²

7. Annexes

7.1 NEN-EN standards

List of a few NEN-EN (European) standards that relate to, among other things, ventilation, indicating which ones are in the Luka Quality Guide. (QG)

NEN-EN 10088-1	Stainless steels part 1, list of stainless steels		2014
NEN-EN 10088-2	Stainless steels: Part 2, Technical delivery conditions for sheet and strip of general purpose corrosion-resistant steels	QG	2014
NEN-EN 10142	Continuous hot-dip galvanised strip and sheet of low-carbon steel for cold drawing or typesetting Technical delivery conditions		2000
NEN-EN 10143	Tolerances on dimensions and shape		2000
NEN-EN 10336	Continuously hot-dip coated and electrolytically coated strip and sheet		2008
NEN-EN 10423	Steel sheet and strip covered with a metal through continuous Tolerances on dimensions and shape	QG	2006
NEN-EN 12097	Ventilation for buildings - Ductwork - Requirements for ductwork components to facilitate maintenance of ductwork systems		2006
NEN-EN 12220	Ventilation for buildings - Ductwork - Dimensions of circular flanges for general ventilation		1998
NEN-EN 12236	Ventilation for buildings - Ductwork hangers and supports - Requirements for strength		2002
NEN-EN 12237	Ventilation for buildings - Ductwork - Strength and leakage of circular sheet metal ducts		2003
NEN-EN 12238	Ventilation for buildings - Air terminal devices - Aerodynamic testing and rating for mixed flow application		2001
NEN-EN 12239	Ventilation for buildings - Air terminal devices - Aerodynamic testing and rating for displacement flow applications		2001
NEN-EN 12589	Ventilation for buildings - Air terminal units - Aerodynamic testing and rating of constant and variable rate terminal units		2001
NEN-EN 12599	Ventilation for buildings - Test procedures and measuring methods for handing over installed ventilation and air conditioning systems		2000
NEN-EN 12792	Ventilation for buildings. Symbols, terminology and graphical symbols		2003
NEN-EN 13030	Ventilation for buildings - Terminals - Performance testing of louvres subjected to simulated rain		2001
NEN-EN 13053	Ventilation for buildings - Air handling units - Ratings and performance for units, components and sections		2006
NEN-EN 13141-1	Ventilation for buildings - Performance testing of components/ products for residential ventilation - Part 1. Externally and internally mounted air transfer devices.		2010
NEN-EN 13141-2	Ventilation for buildings - Performance testing of components/ products for residential ventilation - Part 2. Exhaust and supply air terminal devices		2010
NEN-EN 13141-3	Ventilation for buildings - Performance testing of components/ products for residential ventilation - Part 3. Range hoods for residential use		2004

NEN-EN 13141-4	Ventilation for buildings - Performance testing of components/ products for residential ventilation - Part 4 Fans used in residential ventilation systems		2011
NEN-EN 13141-5	Ventilation for buildings - Performance testing of components/ products for residential ventilation - Part 5 Cowls and roof outlet terminal devices		2004
NEN-EN 13141-6	Ventilation for buildings - Performance testing of components/pro-ducts for residential ventilation - Part 6. Exhaust ventilation system packages used in a single dwelling		2004
NEN-EN 13141-6	Ventilation for buildings - Performance testing of components/ products for residential ventilation - Part 6. Exhaust ventilation system packages used in a single dwelling		2004
NEN-EN 13141-7	Performance testing of components/products for residential ventilation - Part 7: Performance testing of a mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for single family dwellings.		2004
NEN-EN 13141-8	Ventilation for buildings - Performance testing of components/ products for residential ventilation - Part 8: Performance testing of un-ducted mechanical supply and exhaust ventilation units for mechanical ventilation systems		2006
NEN-EN 13142	Ventilation for buildings - Components / product for residential ventilation - Required and optional performances characteristics		2004
NEN-EN 13180	Ventilation for buildings - Ductwork - Dimensions and mechanical requirements for flexible ducts.	QG	2002
NEN-EN 13181	Ventilation for buildings - Terminals - Perfomance testing of louvres Subject to simulated sand		2001
NEN-EN 13182	Ventilation for buildings - Instrumentation requirements for air velocity measurements in ventilated spaces.		2002
NEN-EN 13264	Ventilation for buildings - Terminals - Floor mounted air terminal devices - Tests for structural classification		2001
NEN-EN 13403	Ventilation for buildings. Non metallic ducts. Ductwork made from insulation duckboards	QG	2003
NEN-EN 13465	Ventilation for buildings - Calculation methods for the determination of air flow rates in dwellings		2004
NEN-EN 13501-1	Fire classification of construction products and building elements part 1 classification on the basis of results of reaction-to-fire tests	QG	2009
NEN-EN 1366-1	Determination of fire resistance of installations-Part 1: Ventilation ducts	QG	2014
NEN-EN 1366-2	Determination of fire resistance of installations-Part 2: Fire dampers	QG	1999
NEN-EN 1366-3	Determination of fire resistance of installations-Part 3: Fire resistant sealing systems for penetrations	QG	2009
NEN-EN 13773	Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems		2007
NEN-EN 13829	Thermal performance of buildings - Determination of air permeability of buildings - Fan pressurization method (ISO 9972:1998, modified)		2001
NEN-EN 14134	Ventilation for buildings - Performance testing and installation checks of residential ventilation systems		2004
NEN-EN 14239	Ventilation for buildings - Ductwork - Measurement of ductwork surface area		2004
NEN-EN 14240	Ventilation for buildings - Chilled ceilings - Testing and rating		2004
NEN-EN 14277	Ventilation for buildings - Air terminal devices - Method for airflow measurement by calibrated sensors in or close to ATD/Plenum Boxes		2006
NEN-EN 14308	Insulation Buildings - Factory-made products of rigid polyurethane foam (PUR) and polyisocyanurate foam (PIR) Specifications		
NEN-EN 14518	Ventilation for buildings - Chilled beams - Testing and rating of passive chilled beams		2005

NEN-EN 1505	Ventilation for buildings - Sheet metal air ducts and fittings with rectangular cross section - Dimensions	QG	1998
NEN-EN 1506	Ventilation for buildings - Sheet metal air ducts and fittings with circular cross-section - Dimensions	QG	2007
NEN-EN 1507	Ventilation for buildings - Sheet metal air ducts with rectangular section-Requirements for strength and leakage	QG	2006
NEN-EN 15239	Ventilation for buildings - Energy performance of buildings – Guidelines for inspection of air-conditioning systems.		2007
NEN-EN 15240	Ventilation for Buildings - Energy performance of buildings : Guidelines for the inspection of air--conditioning systems.		2007
NEN-EN 15242	Ventilation for Buildings - Calculation methods for the determination of air flow rates in buildings including infiltration.		2007
NEN-EN 15251	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment lighting and acoustics		2007
NEN-EM 1602	Thermal insulation - determination of apparent density		
NEN-EN 1607	Thermal insulation of buildings- determination of tensile strength perpendicular to		
NEN-EN 1751	Ventilation for buildings-Air terminal devices - Aerodynamic testing of dampers and valves	QG	2014
NEN-EN 1888	Ventilation for buildings - Air handling units - Mechanical performance		2007
NEN -EN 484 1/4	Aluminium and aluminium alloys: sheet and strip.	QG	
NEN-EN ISO 5167-1	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements		
NEN-EN 573 1/5	Aluminium and aluminium alloys: chemical composition and shape of kneaded products	QG	
NEN-EN 779	Particulate air filters for general ventilation - Determination of the filtration performance		2012
NEN-EN 822	Thermal insulation of buildings - determination of length and width		
NEN-EN 823	Thermal insulation of buildings - determination of thickness		

Dutch standards, mentioned in the Luka quality guide.

NEN 6069	Experimental determination of the fire resistance of building components and building products and their classification	QG	
NEW 6076	Experimental determination of fire resistance of ventilation ducts without fire damper; replaced by NEN-EN 1366-1 and NEN-EN 1366-2		
NEW 6077	Experimental determination of fire resistance of ventilation ducts fitted with fire dampers: replaced by NEN-EN 1366-1 and NEN-EN 1366		

NEN-EN 1505	Ventilation for buildings - Sheet metal air ducts and fittings with rectangular cross section - Dimensions	QG	1998
NEN-EN 1506	Ventilation for buildings - Sheet metal air ducts and fittings with circular cross-section - Dimensions	QG	2007
NEN-EN 1507	Ventilation for buildings - Sheet metal air ducts with rectangular section - Requirements for strength and leakage	QG	2006
NEN-EN 15239	Ventilation for buildings - Energy performance of buildings - Guidelines for inspection of ventilation systems		2007
NEN-EN 15240	Ventilation for Buildings - Energy performance of buildings : Guidelines for the inspection of air-conditioning systems.		2007
NEN-EN 15242	Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration.		2007
NEN-EN 15251	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics		2007
NEN-EN 1602	Thermal insulation - determination of apparent density		
NEN-EN 1607	Thermal insulation of buildings- determination of tensile strength perpendicular to.		
NEN-EN 1751	Ventilation for buildings - Air terminal devices - Aerodynamic testing of dampers and valves	QG	2014
NEN-EN 1886	Ventilation for buildings - Air handling units - Mechanical performance		2007
NEN-EN 485 1/4	Aluminium and aluminium alloys: sheet and strip.	QG	
NEN-EN ISO 5167-1	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements		
NEN-EN 573 1/5	Aluminium and aluminium alloys: chemical composition and shape of kneaded products	QG	
NEN-EN 779	Particulate air filters for general ventilation - Determination of the filtration performance		2012
NEN-EN 822	Thermal insulation of buildings - determination of length and width		
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NEN 6077	Experimental determination of fire resistance of ventilation ducts fitted with fire dampers; replaced by NEN-EN 1366-1 and NEN-EN 1366		

7.3 Example Product Label Certificate

Certificate

Basis of assessment	**LUKA quality guide**
Certificate number	**P-97/ 52-XX**

TÜV Rheinland Nederland B.V. hereby declares that deliveries of :

Certificate holder ....

Are checked for production, assembly and airtightness.

Validity	Effective date	**: 1 January ----**
	Expiry date	**: 31 December ----**

TÜV Rheinland Nederland B.V.
PO Box 2220
6802 CE Arnhem

www.tuv.com/nl

TÜVRheinland®
Precisely Right.

7.4 Example Measuring Label Certificate

Certificate

Basis of assessment **Luka quality guide and NEN-EN 1751:2014**

Certificate number **P-97/ 52-XXX**

TÜV Rheinland Nederland B.V. hereby declares that the airtightness measurements on components and fittings of:

Certificate holder ....

Are checked for correct measurement method and measurement results.

Validity

Effective date **: 1 January ----**

Expiry date **: 31 December ----**

TÜV Rheinland Nederland B.V.
PO Box 2220
6802 CE Arnhem

www.tuv.com/nl

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7.5 Quality Certificate

Luka
Nederlandse Vereniging van Luchtkanalenfabrikanten

Kwaliteits Certificaat

Uitgegeven onder verantwoordelijkheid Luka-lid:

Naam

Adres

Postcode/plaats

Projectnaam

De productie, assemblage en montage van de luchttransportsystemen, inclusief appendages, zijn uitgevoerd volgens het meest recente Luka Kwaliteitshandboek. *

De productie en montage van de luchtkanalen zijn uitgevoerd volgens het meest recente Luka Kwaliteitshandboek.

Kenmerk

Besteksbeschrijving van

Besteknummer

Opdrachtgever

Adviseurs

en de luchtdichtheid is gemeten middels een druktest (meetmethode Luka Kwaliteitshandboek) met het resultaat
Luchtdichtheidsklasse volgens NEN-EN 1507:2006 & 12237:2003:

Registratie nummer

De aangegeven onderneming is lid van de Nederlandse Vereniging van Luchtkanalenfabrikanten (Luka) en voert werken uit volgens de kwaliteitsnormen zoals omschreven in het meest recente Luka Kwaliteitshandboek. Het betreffende Lukalid heeft zich onvoorwaardelijk onderworpen aan de collectieve overeenkomst op het gebied van controle van luchttransportsystemen. Deze collectieve overeenkomst is gesloten met TÜV Rheinland Nederland BV.

De onderneming en haar projecten worden regelmatig door TÜV Rheinland Nederland BV bezocht, waarbij de toegepaste materialen, de halffabricaten en de complete en gemonteerde luchttransportsystemen worden gecontroleerd conform het meest recente Luka Kwaliteitshandboek.

Het bovengenoemde project is onderworpen aan de collectieve overeenkomst tussen Luka en TÜV Rheinland Nederland BV.
Door TÜV Rheinland Nederland BV zijn geen tekortkomingen geconstateerd.

Datum

Plaats

* Het betreft hier de versie van het Luka Kwaliteitshandboek zoals vermeld op www.luka.nl ten tijde van de Opdrachtverstrekking.