

Advisory Opinion

*regarding the comparative test and
evaluation of the overall installation costs
of various installed air systems under
consideration of the functional requirements
and seal in accordance with EN 12237 and EN 1507*

TÜV Rheinland Industrie Service GmbH

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CLIENT : Lindab Ventilation AB
Stålhögavägen 115
SE-26982 Båstad

TÜV CUSTOMER NO. : 3080393

TÜV ORDER NO. : 9986501

TYPE OF TEST : Advisory opinion

**ON-SITE EVALUATION
DATES** : 06/30/2008 to 07/04/2008
09/15/2008 and 09/16/2008

CREATED : 07/05/2008 to 07/09/2008
09/15/2008 and 09/16/2008

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NUMBER OF PAGES : 1 - 52

TASK

By order of Lindab Ventilation AB, ventilation duct systems for ventilation and air conditioning systems were inspected for function and seal in accordance with EN 12237/1507 in the factory at SE-26982 Båstad Stålhögavägen 115.

For this, various installed systems were assembled and installation procedures performed, so that they could subsequently be tested for seal in accordance with EN 12237 and EN 1507.

VDI 6022, VDI 3803, DIN 1946-2, and ASR5 were utilized as additional test criteria.

Procedure

In the production area of the abovementioned factory, the following sample systems were set up by the fitters of a local ventilation and air conditioning company. All duct systems were assembled in accordance with the attached sketch. The duct system can be considered to be a typical basic system for a hotel or office building.

In this test, the following systems were assembled:

Creation date	Duct system	Seal	Connection	Cutting method	Collective term
06/30/2008	Spiral duct	PVC tape	Bolted	Abrasive cut-off saw	Vent with tape
07/01/2008	Spiral duct	Sealing compound	Bolted	Abrasive cut-off saw	Vent with mastic
07/01/2008	Spiral duct	Lip seal	Bolted	Elect. metal shears	Safe
07/02/2008	Spiral duct	Lip seal	Click system	Elect. metal shears	Safe-Click
09/15/2008	Rectangular duct	Sealing tape	Bolted	None	Rectangular duct

For these systems, the installation times and the required installation material are recorded.

List of materials				
Designation	Dimension	Material	Individual price	Overall price
	[mm]	[linear meters/unit]	[€]	[€]
Threaded rods				
Nuts				
Washers				
Bolts				
Suspending bracket				
Duct bracket				
Duct				
Elbow				
Reducer				
T-piece				
End cap				
Regulators				
Cold shrink ring				
Self-tapping screws				

For each installation, the attachments were cut and prepared again. As a result, the assembly steps were the same or comparable for all systems.

The different systems were assembled by 2 fitters. The recorded time is also for 2 fitters.

Installation time xx/xx/2008		
Assembly		
Beginning		
End		
Sum		
Additional work		
Beginning		
End		
Work costs		
	2 persons	

To determine price, the offer no. of Lindab Germany and the offer of Massmann Germany were utilized without discount levels.

After the systems were finished, leakage tests were performed on each in accordance with EN 12237/ EN 1507 with two pressure levels.

The leakage test was performed with the leakage test device LT 510 of Lindab, serial number # 1040. The last calibration was on 10/17/2007. (see Appendix)

Pressure and temperature were checked with the Ahlborn Almemo 2290-8 serial number H05030057G, the associated sensor FHA 646-1 last calibration on 06/17/2007 and the pressure module FDA 602-S1K (± 1250 Pa) last calibration on 04/22/2008.

For the duct systems:

1. Duct system made of spiral duct with seal by means of PVC-tape (vent with tape)
2. Duct system made of spiral duct with seal by means of sealing compound (vent with mastic)
3. Duct system made of spiral duct with seal by means of lip seal (bolted connection)(safe)
4. Duct system made of spiral duct with seal by means of lip seal (click connection)(safe-click)

the following parameters result for the leakage test in accordance with EN 12237:

Determination of duct surface area		
Duct dimension	Overall length	Duct area
[mm]	[m]	[m ²]
315	8000	7.9
250	11520	9.0
200	12600	7.9
160	19920	10.0
	Sum	34.9

Determination of butt joint length	
Duct dimension	Overall length
[mm]	[m]
315	11.9
250	9.4
200	7.5
160	28.1
Sum	57.0

This results in the form factor in accordance with EN 12237:

$$\frac{\text{Buttjoint length}}{\text{Surface}} = \frac{57\text{m}}{34.9\text{m}^2} = 1.63\text{m}^{-1}$$

For the duct system 5 duct system made of rectangular duct with seal by means of sealing tape and sealing compound, the following parameters were determined for the leakage test in accordance with EN 1507:

Des.	Item	Number	A	B	C	D	E	F	H	R	G	M	N	Angle
BO	15	12	150	150	0	0	0	0	0	0	0	0	0	0
BO	0	1	400	200	0	0	0	0	0	0	0	0	0	0
BS	20	8	150	150	0	150	50	50	0	100	0	0	0	90
BS	2	1	400	200	0	200	50	50	0	100	0	0	0	90
DK	18	8	150	150	0	0	0	0	0	0	0	0	0	0
EA	16	8	150	150	0	150	125	0	0	0	0	0	0	0
L	12	4	150	150	0	0	0	0	0	0	0	0	0	0
L	17	4	150	150	0	0	0	0	0	0	0	0	0	0
L	8	4	300	200	0	0	0	0	0	0	0	0	0	0
L	5	2	400	200	0	0	0	0	0	0	0	0	0	0
L	6	1	400	200	0	0	0	0	0	0	0	0	0	0
LT	21	4	150	150	0	0	0	0	0	0	0	0	0	0
LT	13	4	150	150	0	0	0	0	0	0	0	0	0	0
LT	19	8	150	150	0	0	0	0	0	0	0	0	0	0
LT	22	2	300	200	0	0	0	0	0	0	0	0	0	0
LT	9	2	300	200	0	0	0	0	0	0	0	0	0	0
LT	24	1	400	200	0	0	0	0	0	0	0	0	0	0
LT	1	1	400	200	0	0	0	0	0	0	0	0	0	0
LT	3	1	400	200	0	0	0	0	0	0	0	0	0	0
TG	14	4	150	150	0	150	0	0	150	100	0	150	150	0
TG	7	2	200	300	0	300	0	0	400	100	0	150	150	0
TG	10	4	200	300	0	300	0	0	300	100	0	150	150	0
TG	4	1	200	400	0	400	0	0	400	100	0	150	150	0
UA	11	6	300	200	150	150	0	-75	0	0	0	0	0	0
UA	23	2	300	200	150	150	-50	-75	0	0	0	0	0	0

A	B	Length	Number	Area
0.15	0.15	2.05	8	9.84
0.2	0.3	0.58	4	2.32
0.2	0.3	0.9	4	3.6
0.2	0.3	5.2	2	10.4
0.15	0.15	2.9	4	6.96
0.2	0.4	6	1	7.2
0.2	0.4	1.65	1	1.98

Sum **42.3** m²

Des.	Item	Number	A	B	Joint
BO	15	12	150	150	7200
BO	0	1	400	200	1200
BS	20	8	150	150	4800
BS	2	1	400	200	1200
DK	18	8	150	150	4800
EA	16	8	150	150	4800
L	12	4	150	150	2400
L	17	4	150	150	2400
L	8	4	300	200	4000
L	5	2	400	200	2400
L	6	1	400	200	1200
LT	21	4	150	150	2400
LT	13	4	150	150	2400
LT	19	8	150	150	4800
LT	22	2	300	200	2000
LT	9	2	300	200	2000
LT	24	1	400	200	1200
LT	1	1	400	200	1200
LT	3	1	400	200	1200
TG	14	4	150	150	2400
TG	7	2	200	300	2000
TG	10	4	200	300	4000
TG	4	1	200	400	1200
UA	11	6	300	200	6000
UA	23	2	300	200	2000

Joint length 71.2 m

This results in a form factor in accordance with EN 1507

$$\frac{\text{Buttjoint length}}{\text{Surface}} = \frac{71.2\text{m}}{42.3\text{m}^2} = 1.68\text{m}^{-1}$$

Test results

Regarding 1. Vent with tape

Here, the entire system (for sketch, see Appendix) was manufactured out of standard components. The spiral duct, which is sold by the meter, was taken from ongoing production. The fittings and the fasteners are equivalent to the commonly available materials. The necessary materials for system 1 can be found in the Appendix.



Illustration 1 - Cutting round duct Illustration 2 – Round duct fittings

The system was assembled on 06/30/08. Then, it was sealed by means of PVC-adhesive tape.

The assembly times were as follows:

Assembly time 06/30/2008		
Assembly		
Beginning	10:00	
End	12:00	2:00
Beginning	12:40	
End	16:15	3:35
Taping		
Beginning	16:15	
End	16:45	0:30
	Sum	6:05

After sealing, the leakage test was performed in accordance with EN 12237.

The duct system, which was closed with end caps, was tested with 400 Pascal positive and negative pressure, as well as with 1000 Pascal positive pressure and 750 Pascal negative pressure.

The test parameters for the system were already determined under Procedure.



Illustration 3 - Sealing with tape



Illustration 4 –Test preparation

	Maximum permissible leakage				Measured leakage	Class
	Class A	Class B	Class C	Class D		
Test pressure	l/s	l/s	l/s	l/s	l/s	passed
+ 400 Pa	46.20	15.40	5.10	1.70	7.63	B
- 400 Pa	46.20	15.40	5.10	1.70	7.46	B
+1000 Pa	83.90	27.90	9.30	3.10	14.33	B
-750 Pa	69.50	23.20	7.70	2.60	11.46	B

For comprehensive protocols, see Appendix.

Regarding 2 Vent with mastic

After removing the tape, the existing system was sealed by means of sealing compound.



Illustration 5 - Cutting round duct



Illustration 6 - Round duct fittings

The amount of materials used and the required assembly times thus correspond to system 1.

The assembly times were as follows:

Assembly time 06/30/2008		
Assembly		
Beginning	10:00	
End	12:00	2:00
Beginning	12:40	
End	16:15	3:35
Calking		
Beginning	17:15	
End	18:05	0:50
	Sum	6:25



Illustration 7 - Calking the duct system



Illustration 8 - Test preparation

The sealing compound mastic Acryl made by Lindab AB was used for sealing. The sealing compound was allowed to dry until the next morning.

On 07/01/2008, a leakage test was performed when the sealing compound was dry.

The duct system, which was closed with end caps, was tested with 400 Pascal positive and negative pressure, as well as with 1000 Pascal positive pressure and 750 Pascal negative pressure.

	Maximum permissible leakage				Measured leakage	Class passed
	Class A	Class B	Class C	Class D		
Test pressure	l/s	l/s	l/s	l/s		
400 Pa+	46.20	15.40	5.10	1.70	7.18	B
400 Pa-	46.20	15.40	5.10	1.70	6.58	B
1000 Pa+	83.90	27.90	9.30	3.10	9.66	B
750 Pa-	69.50	23.20	7.70	2.60	8.42	B

For comprehensive protocols, see Appendix.

Regarding 3. Safe

Here too, the entire system (for sketch, see Appendix) was manufactured out of standard components. The spiral duct, which is sold by the meter, was taken from ongoing production. The fittings and the fasteners are equivalent to the commonly available materials. Suspension was performed with a tool recommended by the manufacturer (electrical metal shears).

The system was assembled on 07/01/08.



Illustration 6 - Cutting to length



Illustration 7 – Sample with lip seal

The assembly times were as follows:

Assembly time 07/01/2008		
Assembly		
Beginning	9:30	
End	12:00	2:30
Beginning	13:00	
End	14:55	1:55
Sum		4:25



Illustration 9 - Detail of lip seal



Illustration 10 - Test preparation

The duct system, which was closed with end caps, was tested with 400 Pascal positive and negative pressure, as well as with 1000 Pascal positive pressure and 750 Pascal negative pressure.

	Maximum permissible leakage				Measured	Class passed
	Class A	Class B	Class C	Class D	leakage	
Test pressure	l/s	l/s	l/s	l/s		
400 Pa+	46.20	15.40	5.10	1.70	0.8	D
400 Pa-	46.20	15.40	5.10	1.70	0.64	D
1000 Pa+	83.90	27.90	9.30	3.10	1.47	D
750 Pa-	69.50	23.20	7.70	2.60	0.94	D

Regarding 4. Safe-Click

The entire system (for sketch, see Appendix) was manufactured out of standard components. The spiral duct, which is sold by the meter, was taken from ongoing production. The fittings and the fasteners are equivalent to the commonly available materials. Suspension was performed with a tool recommended by the manufacturer at an ergonomic working height.

The system was assembled on 07/02/08.

The assembly times were as follows:

Assembly time 07/02/2008		
Assembly		
Beginning	7:30	
End	9:00	1:30
Beginning	9:35	
End	12:00	2:25
Sum		3:55



Illustration 8 - Cutting Safe-Click



Illustration 9 - Fitting Safe-Click

The duct system, which was closed with end caps, was tested with 400 Pascal positive and negative pressure, as well as with 1000 Pascal positive pressure and 750 Pascal negative pressure.

	Maximum permissible leakage				Measured	
	Class A	Class B	Class C	Class D	leakage	Class
Test pressure	l/s	l/s	l/s	l/s		passed
400 Pa+	46.20	15.40	5.10	1.70	0.71	D
400 Pa-	46.20	15.40	5.10	1.70	0.59	D
1000 Pa+	83.90	27.90	9.30	3.10	1.31	D
750 Pa-	69.50	23.20	7.70	2.60	0.85	D

Regarding 5. Rectangular duct (15.09.08)

The entire system (for sketch, see Appendix) was manufactured out of standard components (of German manufacture) and taken from ongoing production. The fittings and the fasteners are equivalent to the commonly available materials.

The system was assembled on 09/15/08 and only tested on 09/16/2008 after a drying period.

Assembly time 09/15/2008		
Assembly		
Beginning	9:15	
End	12:15	3:00
Beginning	13:00	
End	14:30	1:30
Beginning	15:00	
End	18:00	3:00
Beginning	18:30	
End	19:55	1:25
Sum		8:55



Illustration 10
Assembly of the duct system



Illustration 11
Preparation of the duct system

The duct system, which was closed with end caps, was tested with 400 Pascal positive and negative pressure, as well as with 1000 Pascal positive pressure and 750 Pascal negative pressure.

	Permissible leakage				Measured	
	Class A	Class B	Class C	Class D	leakage	Class
Test pressure	l/s	l/s	l/s	l/s		passed
400 Pa+	55.01	18.33	6.11	2.03	7.25	B
400 Pa-	55.83	18.61	6.20	2.06	6.24	B
1000 Pa+	101.92	33.97	11.32	3.77	12.03	B
750 Pa-	84.35	28.11	9.37	3.12	9	C

Other remarks

1. Vent with tape/mastic

- 1.1 When cutting the spiral ducts by means of an abrasive cut-off saw, the sparks are widely distributed. During work preparation, it is essential that precautions be taken with regard to fire alarm systems and ignition risks. In addition, no sensitive areas may be in the cast-off area of the abrasive cut-off saw.



Illustration 12 - Cutting the round spiral duct

- 1.2 Additional deburring of the cut surfaces is also necessary in order to improve the fit as well as for occupational safety.

2. Safe system

Electric metal shears are used to cut the spiral duct.

- 2.1 Selective deburring of the cut surfaces is also necessary in order to improve the fit as well as for occupational safety.
- 2.2 The waste during cutting is limited to approximately 5 mm wide cuttings, which are produced and pose no danger to the surrounding area.



3. Safe-Click system

Electric metal shears are used to cut the spiral duct, which are mounted on the workbench of the SR Cutter.

- 3.1 It is necessary to precisely cut to length, as well as to attach the individual nubs at the correct positions, in order to ensure a continuous work sequence.
- 3.2 The waste during cutting is limited to approximately 5 mm wide cuttings, which are produced and pose no danger to the surrounding area.
- 3.3 Selective deburring of the cut surfaces is also necessary in order to improve the fit as well as for occupational safety.



4. Rectangular duct

With correct installation of rectangular ducts, tight-fitting and strong connections can be created at the flanges. Proper sealing of the insertion flange and the longitudinal fold is obligatory.

Due to the almost unstructured surfaces, rectangular ducts demonstrate deformation during the pressure test with unfavourable aspect ratios and large spans. EN 1507 takes this into account by stipulating that a maximum deformation (denting or bulging) of the duct surface of 3% of the duct dimensions is permissible.

In this case, a deformation of 10 mm was determined with a negative pressure of -750 Pa for the duct pieces with the dimensions of 400 mm x 200 mm. Maximum permissible amount is $400 \text{ mm} \times 3\% = 12 \text{ mm}$.

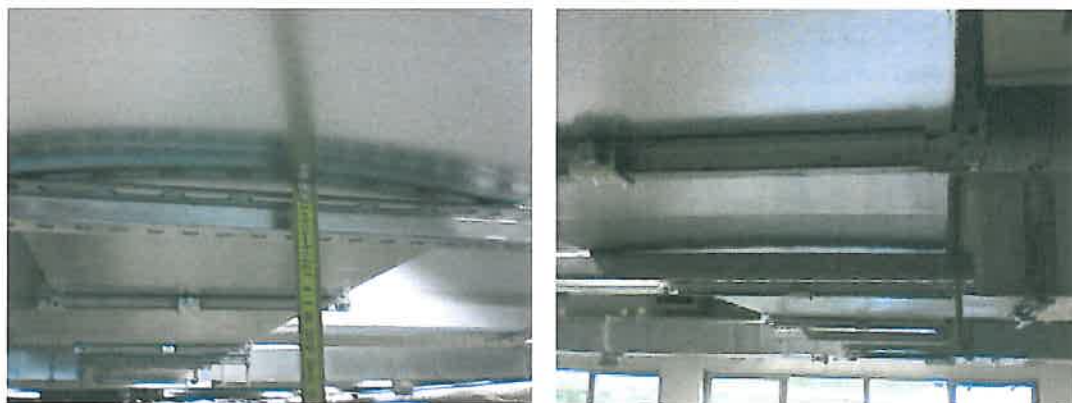
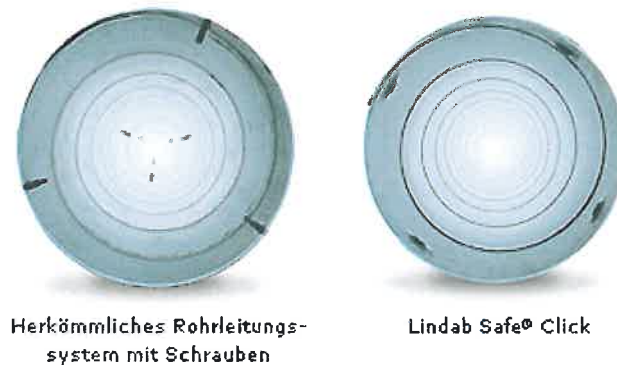


Illustration 13 – Duct deflection with negative pressure -750Pa

Hygienic aspects

For all duct systems, which are attached by means of bolted connections, the bolts protruding into the duct present a cleaning problem and a risk of injury.



Non-structured connection elements, which do not protrude into the air-conducting part of the duct, such as rivet systems or click systems, are therefore fundamentally easier to clean.

Additional aspects

As can be seen in the dimensions previously shown, the ability to achieve certain seal classes does not depend solely upon the duct systems selected.

The respective manufacturing quality of the duct parts and the training level and practical experience of the fitters on-site are also additional important factors.

All seal and connection sites prefabricated under standardized industrial conditions have much better seal values than systems assembled on location.

This can be measured in the Safe and Click-Safe systems, which were two seal classes better than the others.

In addition, the industrial prefabricated systems also have a higher tolerance for assembly errors by inexperienced fitters and the seal classes that can be achieved with them.

Appendix

1. Schematic sketch of the Vent with tape/mastic and Safe/Safe-Click systems

The 3D-views were inserted to clarify the height differences

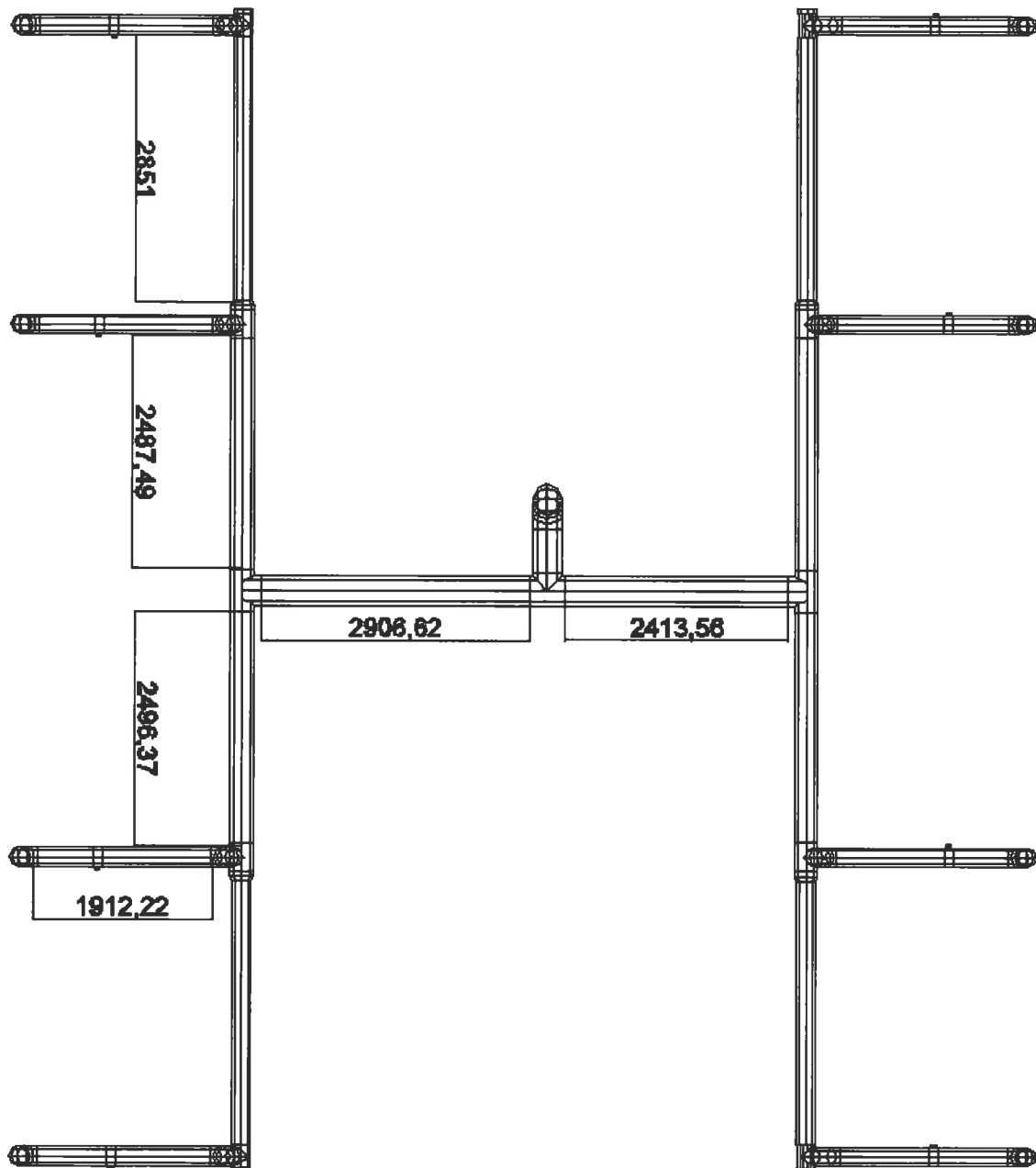


Illustration 14 - Vent with tape/mastic and Safe/Safe-Click systems

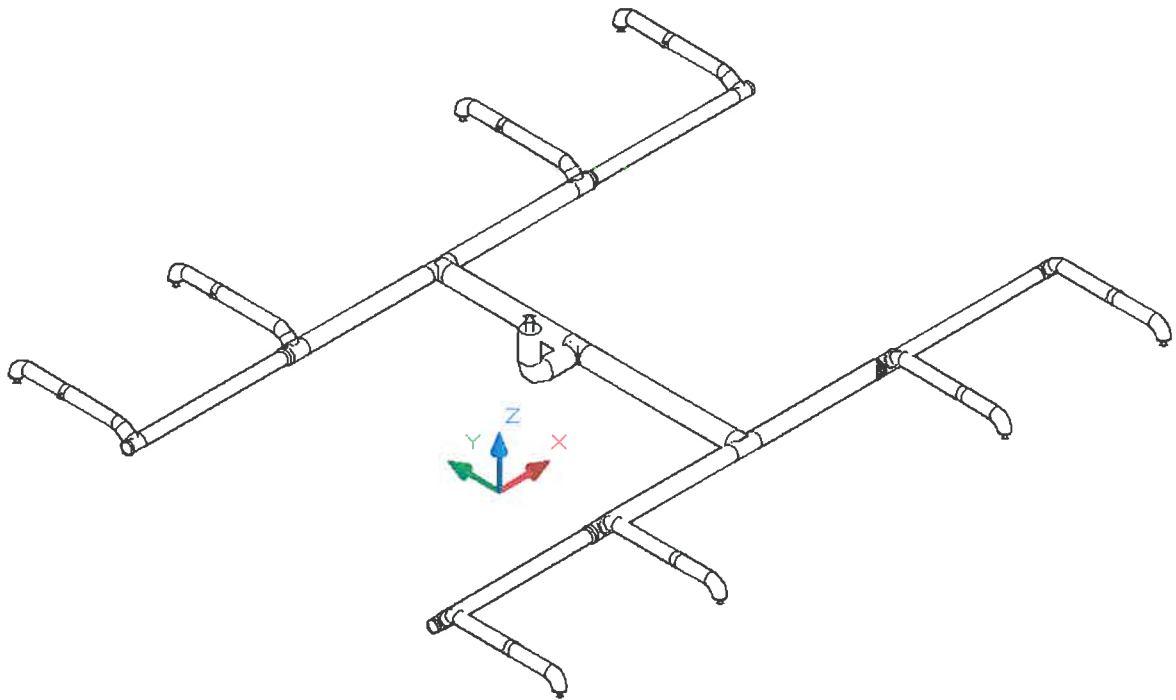


Illustration 15 - Vent with tape/mastic and Safe/Safe-Click systems



Illustration 16 - Vent with tape/mastic and Safe/Safe-Click systems

2. Schematic sketch of the rectangular duct system

The 3D-views were inserted to clarify the height differences

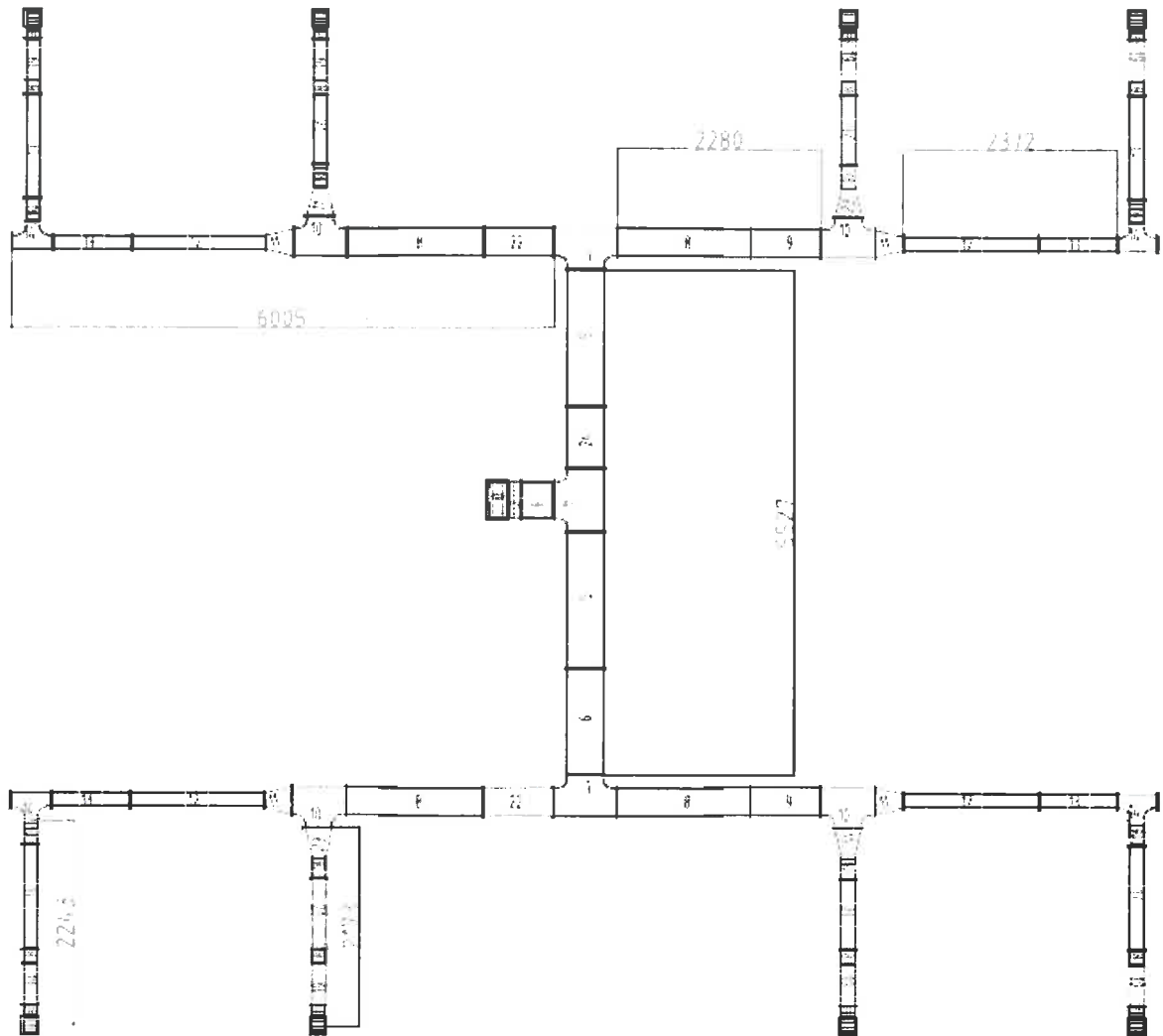


Illustration 17 – Rectangular duct system

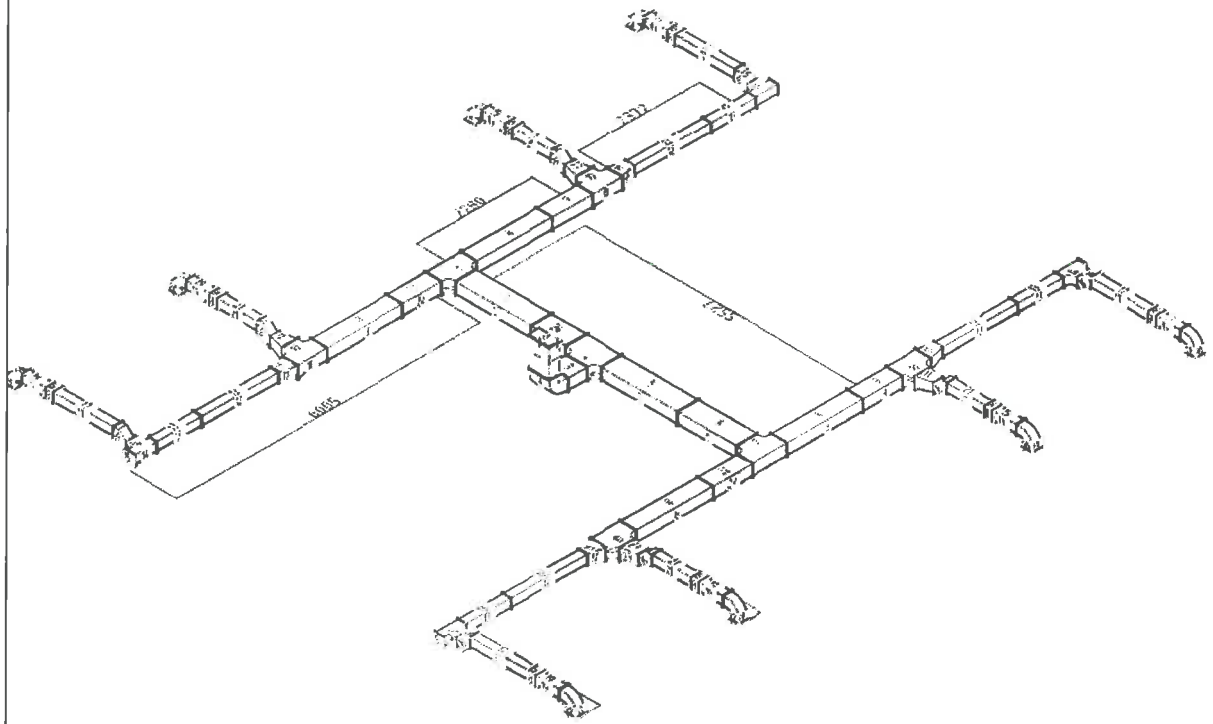


Illustration 18 – Rectangular duct system



Illustration 19 - Rectangular duct system

Materials Vent with tape system

List of materials		Vent with tape	
Designation	Dimension	Quantity	
	[mm]		
Threaded rods	8	25	linear meters
Nuts	8	90	units
Washers	8	30	units
Bolts	8	30	units
Suspending bracket	8	30	linear meters
Duct bracket	315	4	units
	250	6	units
	200	4	units
	160	16	units
Duct	315	8.07	linear meters
	250	11.52	linear meters
	200	12.6	linear meters
	160	20.16	linear meters
Elbow	90°/315	1	unit
	90°/160	8	units
	45°/160	8	units
Reducer	315/250	4	units
	250/200	4	units
T-piece	315/315	3	units
	250/250	4	units
	200/200	4	units
End cap	200	4	units
	160	8	units
Circuit controls	160	8	units
PVC tape	10000	6	units
Self-tapping screws	4.2 x 9.5	276	units

Materials Vent with mastic system

List of materials		Vent with mastic	
Designation	Dimension	Quantity	
	[mm]		
Threaded rods	8	25	linear meters
Nuts	8	90	units
Washers	8	30	units
Bolts	8	30	units
Suspending bracket	8	30	linear meters
Duct bracket	315	4	units
	250	6	units
	200	4	units
	160	16	units
Duct	315	8.07	linear meters
	250	11.52	linear meters
	200	12.6	linear meters
	160	20.16	linear meters
Elbow	90°/315	1	unit
	90°/160	8	units
	45°/160	8	units
Reducer	315/250	4	units
	250/200	4	units
T-piece	315/315	3	units
	250/250	4	units
	200/200	4	units
End cap	200	4	units
	160	8	units
Circuit controls	160	8	units
Acrylic mastic		6	units
Self-tapping screws	4.2 x 9.5	276	units

List of materials Safe system

List of materials		Safe	
Designation	Dimension	Quantity	
	[mm]		
Threaded rods	8	25	linear meters
Nuts	8	96	units
Washers	8	32	units
Bolts	8	32	units
Suspending bracket	8	32	linear meters
Duct bracket	315	4	units
	250	8	units
	200	4	units
	160	16	units
Duct	315	8.07	linear meters
	250	11.52	linear meters
	200	12.6	linear meters
	160	20.16	linear meters
Elbow	90°/315	1	unit
	90°/160	8	units
	45°/160	8	units
Reducer	315/250	4	units
	250/200	4	units
T-piece	315/315	3	units
	250/250	4	units
	200/200	4	units
End cap	200	4	units
	160	8	units
Circuit controls	160	8	units
Self-tapping screws	4.2 x 9.5	276	units

List of materials Safe-click system

List of materials		Safe-Click	
Designation	Dimension	Quantity	
	[mm]		
Threaded rods	8	25	linear meters
Nuts	8	96	units
Washers	8	32	units
Bolts	8	32	units
Suspending bracket	8	32	linear meters
Duct bracket	315	4	units
	250	8	units
	200	4	units
	160	16	units
Duct	315	8.07	linear meters
	250	11.52	linear meters
	200	12.6	linear meters
	160	20.16	linear meters
Elbow	90°/315	1	unit
	90°/160	8	units
	45°/160	8	units
Reducer	350/250	4	units
	250/200	4	units
T-piece	315/315	3	units
	250/250	4	units
	200/200	4	units
End cap	200	4	units
	160	8	units
Circuit controls	160	8	units

List of materials rectangular duct system

Des.	Item	Number	A	B	C	D	E	F	H	R	G	M	N	Angle
			mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	°
BO	15	12	150	150	0	0	0	0	0	0	0	0	0	0
BO	0	1	400	200	0	0	0	0	0	0	0	0	0	0
BS	20	8	150	150	0	150	50	50	0	100	0	0	0	90
BS	2	1	400	200	0	200	50	50	0	100	0	0	0	90
DK	18	8	150	150	0	0	0	0	0	0	0	0	0	0
EA	16	8	150	150	0	150	125	0	0	0	0	0	0	0
L	12	4	150	150	0	0	0	0	0	0	0	0	0	0
L	17	4	150	150	0	0	0	0	0	0	0	0	0	0
L	8	4	300	200	0	0	0	0	0	0	0	0	0	0
L	5	2	400	200	0	0	0	0	0	0	0	0	0	0
L	6	1	400	200	0	0	0	0	0	0	0	0	0	0
LT	21	4	150	150	0	0	0	0	0	0	0	0	0	0
LT	13	4	150	150	0	0	0	0	0	0	0	0	0	0
LT	19	8	150	150	0	0	0	0	0	0	0	0	0	0
LT	22	2	300	200	0	0	0	0	0	0	0	0	0	0
LT	9	2	300	200	0	0	0	0	0	0	0	0	0	0
LT	24	1	400	200	0	0	0	0	0	0	0	0	0	0
LT	1	1	400	200	0	0	0	0	0	0	0	0	0	0
LT	3	1	400	200	0	0	0	0	0	0	0	0	0	0
TG	14	4	150	150	0	150	0	0	150	100	0	150	150	0
TG	7	2	200	300	0	300	0	0	400	100	0	150	150	0
TG	10	4	200	300	0	300	0	0	300	100	0	150	150	0
TG	4	1	200	400	0	400	0	0	400	100	0	150	150	0
UA	11	6	300	200	150	150	0	-75	0	0	0	0	0	0
UA	23	2	300	200	150	150	-50	-75	0	0	0	0	0	0

Designation	Quantity	
Threaded rods	53.5	linear meters
Nuts	160	units
Washers	80	units
Bolts	0	units
Support clips	25	units
Butyl sealing compound	5	kg
Brush	2	units

Conclusion

By order of Lindab Ventilation AB Schweden, a comparative test for the evaluation of the overall installation costs of various installed air systems under consideration of the functional requirements and seal in accordance with EN 12237/1507 was performed in Sweden.

A total of 5 different systems were installed and evaluated.

1. duct system made of spiral duct with seal by means of PVC-Band (**Vent with tape**)
2. duct system made of spiral duct with seal by means of sealing compound (**Vent with mastic**)
3. duct system made of spiral duct with seal by means of lip seal (**Safe**)
4. duct system made of spiral duct with seal by means of lip seal (**Safe- Click**)
5. duct system made of rectangular duct with seal by means of sealing tape and sealing compound (**rectangular duct**)

All systems were set up with the same dimensions by a local ventilation and air conditioning company.

The assembly times were as follows:

	Assembly time	Time (%)	Difference (%)
Vent with tape	06:05	155%	55%
Vent with mastic	06:25	164%	64%
Safe	04:25	113%	13%
Safe-Click	03:55	100%	0%
Rectangular duct	08:55	228%	128%

The costs and assembly times were as follows (based on Safe® Click):

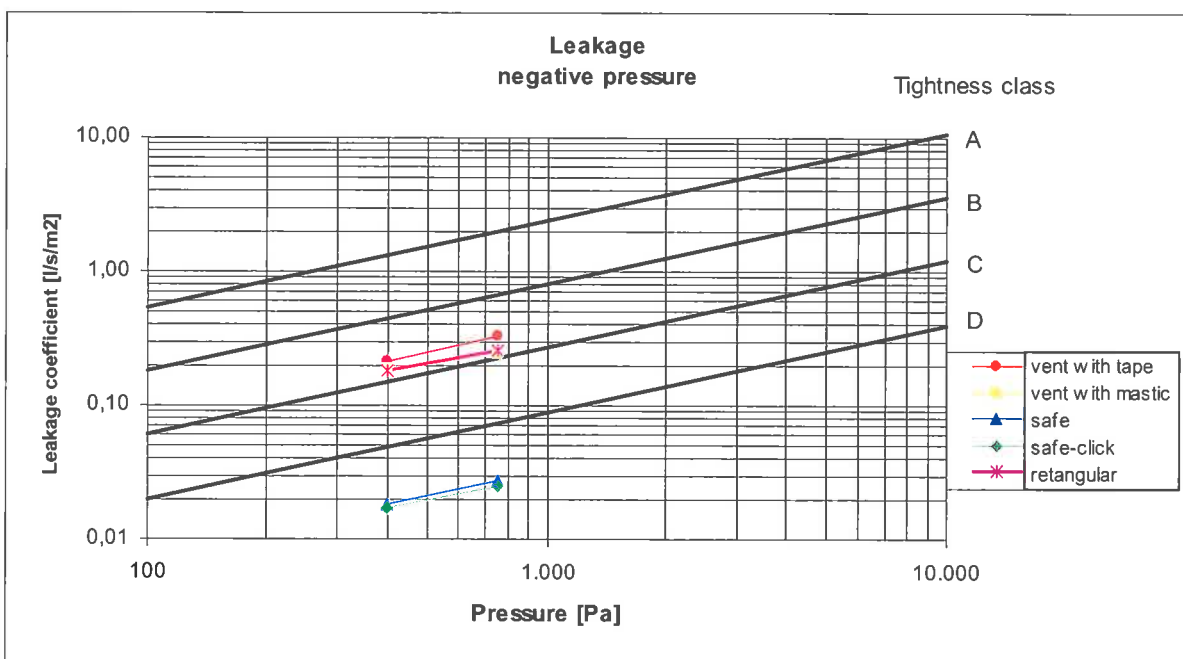
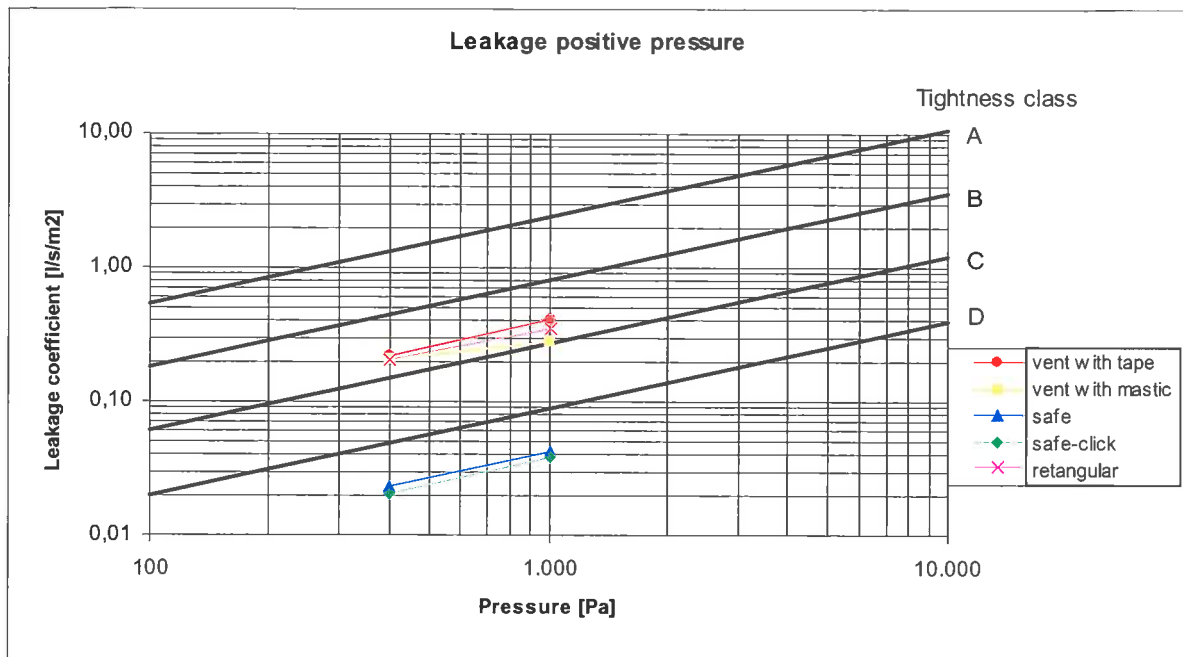
	Effort		Costs			Deviations		Hourly wage
	Work time		Assembly	Material	Total	Time	Costs	[€/h]
	2 persons	1 person						50.00 €
Vent with tape	06:05	12:10	608.33 €	1,390.82 €	1,999.15 €	55,32%	7,54%	basis
Vent with mastic	06:25	12:50	641.67 €	1,409.12 €	2,050.79 €	63,83%	10,32%	
Safe®	04:25	08:50	441.67 €	1,467.26 €	1,908.93 €	12,77%	2,69%	
Safe® Click	03:55	07:50	391.67 €	1,467.26 €	1,858.93 €	0,00%	0,00%	
Rectangular duct	08:55	17:50	891.67 €	1,684.83 €	2,576.49 €	127,66%	38,60%	

The leakage rates of the systems were as follows:

	Leakage rate		Class A	Class B	Class C	Class D	Class
	400Pa+	400Pa-	l/s	l/s	l/s	l/s	passed
Vent with tape	7.63	7.46	46.20	15.40	5.10	1.70	B
Vent with mastic	7.18	6.58	46.20	15.40	5.10	1.70	B
Safe	0.80	0.64	46.20	15.40	5.10	1.70	D
Safe Click	0.71	0.59	46.20	15.40	5.10	1.70	D
Rectangular duct	7.25	6.24	55.00	18.30	6.10	2.00	B

	in acc. with leakage rate	Class A	Class B	Class C	Class D	Class
	1000Pa+	l/s	l/s	l/s	l/s	passed
Vent with tape	14.33	83.90	27.90	9.30	3.10	B
Vent with mastic	9.66	83.90	27.90	9.30	3.10	B
Safe	1.47	83.90	27.90	9.30	3.10	D
Safe Click	1.31	83.90	27.90	9.30	3.10	D
Rectangular duct	12.03	101.92	33.97	11.32	3.77	B

	in acc. with leakage rate	Class A	Class B	Class C	Class D	Class
	750Pa-	l/s	l/s	l/s	l/s	passed
Vent with tape	11.46	83.90	27.90	9.30	3.10	B
Vent with mastic	8.42	83.90	27.90	9.30	3.10	B
Safe	0.94	83.90	27.90	9.30	3.10	D
Safe Click	0.85	83.90	27.90	9.30	3.10	D
Rectangular duct	9.00	84.35	28.11	9.37	3.12	C



Koblenz, 04/03/2009

The Expert

Peter Hofmeister / graduate engineer (FH)



Testresult

LEAKAGE TEST

*** Lindab L⁵IC ***

Version 1.8

Test report ID# 197

Leakage test report of
air ducts in accordance
to EN12237, EN1587 and
EN12599

Test object info: 1.000

Surface area 34.0 m²
Tightness class B
Rate factor 9 l/s / m²
Pressure 400 Pa

Test pressure 400 Pa
Leakage rate 7.15 l/s
Endurance 300 sec

Limit at A 1.11 l/s
Limit at B 1.38 l/s
Limit at C 5.12 l/s
Limit at D 1.70 l/s

Result
Test object OK

Date 30 06 2008

Time 17 07

Signature

*** Lindab L⁵IC ***

Version 1.8

Test report ID# 196

Leakage test report of
air ducts in accordance
to EN12237, EN1587 and
EN12599

Test object info: 1.000

Surface area 34.0 m²
Tightness class B
Rate factor 9 l/s / m²
Pressure 400 Pa

Test pressure 400 Pa
Leakage rate 7.63 l/s
Endurance 300 sec

Limit at A 45.29 l/s
Limit at B 15.42 l/s
Limit at C 5.14 l/s
Limit at D 1.71 l/s

Result
Test object OK

Date 30 06 2008

Time 17 00

Signature

Spiral duct assembling bolted Sealing Tape



LEAKAGE TEST
 **** Lindab L1510 ****
 Version : 8

Test report ID# 198

Leakage test report of
 air ducts in accordance
 to EN12237, EN1507 and
 EN12599

Test object information

Surface area 34.9 m²
 Tightness cl B
 Rate factor 9 l/s 1/m²
 Pressure 750 Pa

Test pressure 750 Pa
 Leakage rate 11.46 l/s
 Endurance 300 sec

Limit at A 59.53 l/s
 Limit at B 23.17 l/s
 Limit at C 7.72 l/s
 Limit at D 2.97 l/s

Result
 Test object OK

Date 30.06.08

Time 17.15

Signature

LEAKAGE TEST
 **** Lindab L1510 ****
 Version : 8

Test report ID# 199

Leakage test report of
 air ducts in accordance
 to EN12237, EN1507 and
 EN12599

Test object information

Surface area 34.9 m²
 Tightness cl B
 Rate factor 9 l/s 1/m²
 Pressure 1000 Pa

Test pressure 1000 Pa
 Leakage rate 14.33 l/s
 Endurance 300 sec

Limit at A 53.58 l/s
 Limit at B 27.99 l/s
 Limit at C 9.33 l/s
 Limit at D 3.11 l/s

Result
 Test object OK

Date 30.06.2008

Time 17.22

Signature

Spiral duct assembling bolted Sealing Tape



LEAKAGE TEST
 **** Lindab L1510 ****
 Version: 1.8

Test report ID# 202
 Leakage test report of
 air ducts in accordance
 to EN12237, EN1507 and
 EN12599

Test object information
 Surface area 34.9 m²
 Tightness class B
 Rate factor 9 l/s m²
 Pressure 400 Pa

Test pressure 399 Pa
 Leakage rate 6.50 l/s
 Endurance 100 min

Limit at A 40.21 l/s
 Limit at B 15.40 l/s
 Limit at C 5.13 l/s
 Limit at D 1.71 l/s

Result:
 Test object OK

Date 01.07.2008

Time 07.33

Signature

LEAKAGE TEST
 **** Lindab L1510 ****
 Version: 1.8

Test report ID# 201
 Leakage test report of
 air ducts in accordance
 to EN12237, EN1507 and
 EN12599

Test object information
 Surface area 34.9 m²
 Tightness class B
 Rate factor 9 l/s m²
 Pressure 400 Pa

Test pressure 399 Pa
 Leakage rate 7.19 l/s
 Endurance 100 min

Limit at A 45.99 l/s
 Limit at B 15.33 l/s
 Limit at C 5.11 l/s
 Limit at D 1.70 l/s

Result:
 Test object OK

Date 01.07.2008

Time 07.20

Signature

Spiral duct assembling bolted Sealing Acryl-Mastic



LEAKAGE TEST
 **** Lindab 17510 ****
 Version 1.8

Test report ID# 203
 Leakage test report of
 air ducts in accordance
 to EN12237, EN1407 and
 EN12599

Test object information
 Surface area 34.9 m²
 Tightness class B
 Rate factor 9 l/s m²
 Pressure -750 Pa

Test pressure -747 Pa
 Leakage rate 8.42 l/s
 Endurance 300 sec

Limit at A 59.47 l/s
 Limit at B 23.15 l/s
 Limit at C 7.71 l/s
 Limit at D 2.57 l/s

Result:
 Test object OK

Date 01.07.2008

Time 07.40

Signature

LEAKAGE TEST
 **** Lindab 17510 ****
 Version 1.8

Test report ID# 203
 Leakage test report of
 air ducts in accordance
 to EN12237, EN1407 and
 EN12599

Test object information
 Surface area 34.9 m²
 Tightness class B
 Rate factor 9 l/s m²
 Pressure -1000 Pa

Test pressure -1000 Pa
 Leakage rate 9.66 l/s
 Endurance 300 sec

Limit at A 83.98 l/s
 Limit at B 27.99 l/s
 Limit at C 9.33 l/s
 Limit at D 3.11 l/s

Result:
 Test object OK

Date 01.07.2008

Time 07.45

Signature

Spiral duct assembling bolted Sealing Acryl-Mastic



LEAKAGE TEST
 *** Lindab L7510 ***
 Version 1 B

Test report IQ# 207

Leakage test report of
 air ducts in accordance
 to EN12237, EN1587 and
 EN12599

Test object information

Surface area 34.9 m²
 Tightness class D
 Rate factor 1 l/s / m²
 Pressure -400 Pa

Test pressure -399 Pa
 Leakage rate 0.54 l/s
 Endurance 300 sec

Limit at A 16.21 l/s
 Limit at B 15.40 l/s
 Limit at C 5.13 l/s
 Limit at D 1.71 l/s

Result
 Test object OK

Date: 01.07.2008

Time: 15:22

Signature

LEAKAGE TEST
 *** Lindab L7510 ***
 Version 1 B

Test report IQ# 206

Leakage test report of
 air ducts in accordance
 to EN12237, EN1587 and
 EN12599

Test object information

Surface area 34.9 m²
 Tightness class D
 Rate factor 1 l/s / m²
 Pressure -750 Pa

Test pressure -750 Pa
 Leakage rate 0.94 l/s
 Endurance 300 sec

Limit at A 69.65 l/s
 Limit at B 23.71 l/s
 Limit at C 7.73 l/s
 Limit at D 2.57 l/s

Result
 Test object OK

Date: 01.07.08

Time: 15:30

Signature

Spiral duct Safe assembling bolted Sealing Safe



LEAKAGE TEST
 **** Lindab LT510 ****
 Version 1.8

Test report ID# 285

Leakage test report of
 air ducts in accordance
 to EN12237, EN1587 and
 EN12599

Test object information
 Surface area 34.9 m²
 Tightness class D
 Rate factor 1 l/s 1/m²
 Pressure 400 Pa

Test pressure 431 Pa
 Leakage rate 0.80 l/s
 Endurance 300 sec

Limit at A 46.36 l/s
 Limit at B 35.45 l/s
 Limit at C 9.15 l/s
 Limit at D 1.71 l/s

Result
 Test object OK

Date: 01.07.2008

Time: 15.05

Signature

LEAKAGE TEST
 **** Lindab LT510 ****
 Version 1.8

Test report ID# 205

Leakage test report of
 air ducts in accordance
 to EN12237, EN1587 and
 EN12599

Test object information
 Surface area 34.9 m²
 Tightness class D
 Rate factor 1 l/s 1/m²
 Pressure 1000 Pa

Test pressure 999 Pa
 Leakage rate 1.47 l/s
 Endurance 300 sec

Limit at A 83.92 l/s
 Limit at B 27.97 l/s
 Limit at C 9.32 l/s
 Limit at D 3.10 l/s

Result
 Test object OK

Date: 01.07.2008

Time: 15.15

Signature

Spiral duct Safe assembling bolted Sealing Safe



LEAKAGE TEST
**** Lindab L1510 ****
Version 1.8

Test report ID# 210
Leakage test report of
air ducts in accordance
to EN12237, EN1507 and
EN12599

Test object information
Surface area 34.9 m²
Lightness class D
Rate factor 1/4 l/m²
Pressure 1000 Pa

Test pressure 1000 Pa
Leakage rate 0.71 l/s
Endurance 300 s

Limit at A 45.44 l/s
Limit at B 15.48 l/s
Limit at C 5.16 l/s
Limit at D 1.72 l/s

Result
Test object OK

Date 02.07.2008

Time 12.55

Signature:

LEAKAGE TEST
**** Lindab L1510 ****
Version 1.8

Test report ID# 211
Leakage test report of
air ducts in accordance
to EN12237, EN1507 and
EN12599

Test object information
Surface area 34.9 m²
Lightness class D
Rate factor 1/4 l/m²
Pressure 1000 Pa

Test pressure 1000 Pa
Leakage rate 1.31 l/s
Endurance 300 s

Limit at A 83.96 l/s
Limit at B 27.99 l/s
Limit at C 9.33 l/s
Limit at D 3.11 l/s

Result
Test object OK

Date 02.07.2008

Time 13.03

Signature:

Spiral duct Safe-Click assembling Click Sealing Safe



LEAKAGE TEST

**** Lindab 11512 ***
Version: 1.8

Test report ID# 212

Leakage test report of
air ducts in accordance
to EN12237, EN1587 and
EN12599

Test object information

Surface area: 34.9 m²
Tightness class: 0
Rate factor: 1 l/s l/m²
Pressure: -400 Pa

Test pressure: 400 Pa
Leakage rate: 0.99 l/s
Endurance: 300 sec

Limit at A: 46.29 l/s
Limit at B: 15.43 l/s
Limit at C: 5.14 l/s
Limit at D: 1.71 l/s

Result
Test object OK

Date: 02.07.2008

Time: 13.10

Signature:

LEAKAGE TEST

**** Lindab 11510 ***
Version: 1.8

Test report ID# 214

Leakage test report of
air ducts in accordance
to EN12237, EN1587 and
EN12599

Test object information

Surface area: 34.9 m²
Tightness class: 0
Rate factor: 1 l/s l/m²
Pressure: -750 Pa

Test pressure: 750 Pa
Leakage rate: 0.85 l/s
Endurance: 300 sec

Limit at A: 69.96 l/s
Limit at B: 23.32 l/s
Limit at C: 7.77 l/s
Limit at D: 2.59 l/s

Result
Test object OK

Date: 02.07.2008

Time: 13.16

Signature:

Spiral duct Safe-Click assembling Click Sealing Safe



LEAKAGE TEST

**** Lindab 17510 ****
Version: 1.8

Test report ID# 228

Leakage test report of
air ducts, in accordance
to EN12237, EN15907 and
EN12599

Test object information

Surface area: 42.3 m²
Tightness class: C
Rate factor: 3 l/s / m²
Pressure: 1000 Pa

Test pressure: 1000 Pa
Leakage rate: 12.03 l/s
Endurance: 300 min

Limit at A: 31.92 l/s
Limit at B: 24.97 l/s
Limit at C: 11.32 l/s
Limit at D: 3.17 l/s

Result
Test object: OK

Date: 16.09.08

Time: 9.15

Signature:

LEAKAGE TEST

**** Lindab 17510 ****
Version: 1.8

Test report ID# 229

Leakage test report of
air ducts, in accordance
to EN12237, EN15907 and
EN12599

Test object information

Surface area: 42.3 m²
Tightness class: C
Rate factor: 3 l/s / m²
Pressure: 750 Pa

Test pressure: 750 Pa
Leakage rate: 9.00 l/s
Endurance: 300 min

Limit at A: 31.99 l/s
Limit at B: 24.11 l/s
Limit at C: 9.37 l/s
Limit at D: 3.17 l/s

Result
Test object: OK

Date: 16.09.08

Time: 09.02

Signature:

Rectangular system



LEAKAGE TEST
**** Lindab 1910 ****
Version: 1.8

Test report ID# 226

Leakage test report of
air ducts in accordance
to EN12237, EN12597 and
EN12599

Test object: 3 floor kitchen

Surface area 42.3 m²
Tightness class C
Rate factor 3 l/s m²
Pressure 100 Pa

Test pressure 100 Pa
Leakage rate 7.25 l/s
Endurance 100 sec

Limit at A 15.0 l/s
Limit at B 12.5 l/s
Limit at C 6.1 l/s
Limit at D 2.83 l/s

Result
Test object: OK

Date 16 09 08

Time 8 40

Signature

LEAKAGE TEST
**** Lindab 1910 ****
Version: 1.8

Test report ID# 227

Leakage test report of
air ducts in accordance
to EN12237, EN12597 and
EN12599

Test object: 3 floor kitchen

Surface area 42.3 m²
Tightness class C
Rate factor 3 l/s m²
Pressure 100 Pa

Test pressure 100 Pa
Leakage rate 0.24 l/s
Endurance 100 sec

Limit at A 15.0 l/s
Limit at B 12.5 l/s
Limit at C 6.1 l/s
Limit at D 2.83 l/s

Result
Test object: OK

Date 16 09 08

Time 8 50

Signature

Rectangular system



Calibration report LT 510

Production final test report Leakage Tester LT 510

WÖHLER
MESSGERÄTE KEHRGERÄTE GmbH

Serial #:	1040
------------------	------

Calibration settings:

P	1432
w/o	900
TYP1	781
TYP2	892
Firmware	LT510E13
Logo	auto

Pressure:

Reference	Reading
400 Pa	400 Pa
2000 Pa	2024 Pa

Flowrate:

Reference	Reading
0,00 l/s	0,00 l/s
2,01 l/s	2,03 l/s
6,02 l/s	6,09 l/s
39,96 l/s	39,75 l/s

Flowrate Reference	Venturiröhr #507 DKD-K-05701 88-01	
	Venturiröhr #508 DKD-K-05701 90-01	
	Venturiröhr #1322 DKD-K-05701 06-12	
Pressure Reference	10000 Pa Typ: KAL 100 Halbsnap S-Nr. 9905 9046	
Pressure Reference	1000 Pa Typ: KAL 100 Halbsnap S-Nr. 160797020134	
Temperature / Pressure	30 °C	882 hPa
Date / Signature	17.10.2007	RRU

Preparations for assembly

- Check that ducts and fittings to be used in the system are labelled as shown above.
- Store ducts and fittings in a well-ordered and weatherproof storage area to minimize the risk of damage. Do not use ducts or fittings that have been damaged in such a way that they jeopardise the air tightness or structural strength of the system.

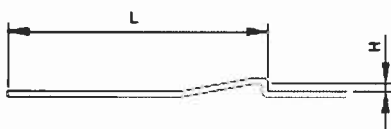
Lindab Safe

- Cut ducts at right angles. Carefully remove any burrs from cut edges. Installation is easier and the risk of damaging the gasket is reduced if there are no burrs.
Also cut away the two needles created from the fold.
- Carefully seal any holes left by measurements, removed screws, blind rivets, etc.

Lindab Safe Click

- Cut ducts at right angles. This is an uncompromisable demand for Lindab Safe Click. Carefully remove any burrs from cut edges. Installation is easier and the risk of damaging the gasket is reduced if there are no burrs.
Also cut away the two needles created from the fold.
- If a duct is cut – make notches around its circumference. See table 1 and 2.
- Carefully seal any holes left by measurements etc.

Table 1. Size and location of notches



Ø [mm]	Click Pliers		L [mm]
	40.1	60.1	
80-224	H _{min} [mm] 2,0	H _{min} [mm] –	30,5-32,5
250-315	H _{min} [mm] –	H _{min} [mm] 2,5	50,5-52,5

Table 2. Number of fasteners and notches

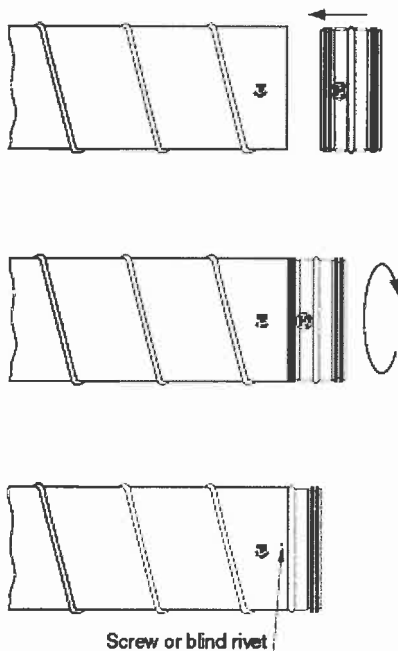
Lindab Safe		Lindab Safe Click	
Ø [mm]	Minimum number of fasteners required to achieve sufficient strength.	Click Pliers	
		40.1	60.1
63	2	–	–
80-112	2	2	–
125-160	3	4	–
180-224	3	4	–
250-315	4	–	4
355-630	4	–	–
710-1250	6	–	–
Depending on the means of suspension, a larger number of fasteners than this may be required to achieve sufficient structural strength of a duct system		Depending on the means of suspension, a larger number of notches than this may be required to achieve sufficient structural strength of a duct system. A greater number of notches makes it harder to assemble the parts.	

Assembly

Lindab Safe

- 1 Start by inserting the turned-over edge of the fitting into the duct.
- 2 Check that the first lip of the gasket is in contact with the edge of the duct all the way around and sticks straight out so that the lip is not twisted in one direction or the other.
- 3 Push the end of the fitting into the duct. Twisting the fitting slightly aids insertion.
- 4 Secure the fitting in the duct using self-tapping screws or airtight blind rivets. NOTE! Use only the types allowed by Lindab when going for tightness class C or D. See table 3.
- 5 Fasteners should be positioned 10–15 mm from the end of the duct to prevent damage to the gasket.
- 6 Always position fasteners at the present largest radial gap between fitting and duct. Be sure to achieve an even distribution around the circumference.

Lindab Safe



Lindab Safe Click

- 1 Start by inserting the turned-over edge of the fitting into the duct.
- 2 Check that the first lip of the gasket is in contact with the edge of the duct all the way around and sticks straight out so that the lip is not twisted in one direction or the other.
- 3 Push the end of the fitting into the duct. Twisting and bending the fitting slightly aids insertion.
- 4 The fitting is secured to the duct when the end of the fitting snaps behind the notches.

Lindab Safe Click

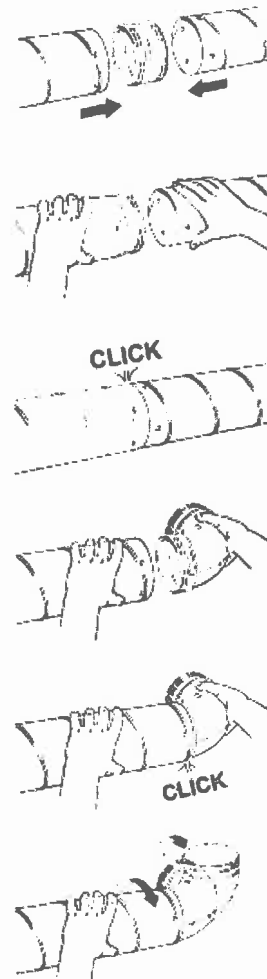
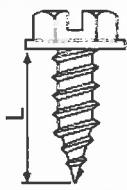
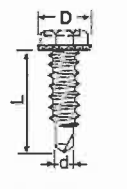
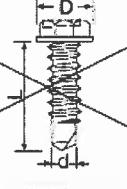




Table 3. Allowed and banned screws and blind rivets

	<p>Screw with sharp tip</p> <ul style="list-style-type: none"> • Very tight • Strong since it forms a collar in the thin sheet metal 	<p>Allowed by Lindab</p>
	<p>Screw with reduced drill tip</p> <ul style="list-style-type: none"> • Very tight • Strong since it only drills off a small part of the thin sheet metal 	<p>Allowed by Lindab</p>
	<p>Screw with drill tip</p> <ul style="list-style-type: none"> • Not tight • Weak since it drills off a big part of the thin sheet metal 	<p>Banned by Lindab</p>
	<p>Pressure-tight blind rivet</p> <ul style="list-style-type: none"> • Very tight • Strong • Very laborious to install 	<p>Allowed by Lindab</p>
	<p>Blind rivet</p> <ul style="list-style-type: none"> • Not tight if the inner splint falls out • Strong • Laborious to install 	<p>Banned by Lindab</p>

Hints!

Turning and bending the fitting slightly as you insert it into the duct aids assembly and removal.

If ducts and fittings are round, assembly is much easier. Lindab has placed high demands on roundness during the design and production stages, but large heavy fittings in particular have a tendency to be slightly oval because of their weight. These often become round when suspended, which is why you should use the brackets to make the components round and in this way simplify assembly.

Carefully tapping the surface of the duct with your hand normally makes assembly a lot easier, as it reduces the friction between duct and fitting, and the fitting tries to move to the right side if there are burrs and irregularities.

When cutting, be sure to remove burrs properly. Also cut away the two needles created from the fold.

For larger dimensions, Lindab has moved the gasket away from the edge, which makes assembly much easier.

If you have to reinstall a product, take care to seal old holes from screws or blind rivets which can cause leaks and noise.

Products with special seals

Some fittings, such as the collar saddle PSU, T-pieces TSTCU, TSTU and take-offs ILRU, ILU, ILF, have one more connection than Lindab Safe or Lindab Safe Click. This connection must be sealed so that they definitely meet the requirements for air-tightness class C or D. Sealing material used must be durable and permanently elastic.

Products without Click

Some fittings, such as the slide-in female coupling SMFU, the end caps EPF and ESU and of course the cleaning covers EPFH, ESHU, KCU and KCIUV, do not have any Click function in order to make them easier to remove.

Use of products other than Lindab Safe or Lindab Safe Click

Products that do not formally fulfil the requirements for air tightness class C or D may only be used to a small extent. If such items are used, they must be carefully checked with regard to seal design and strength. They must be sealed so that they definitely meet the requirements for air-tightness class C or D. Sealing material used must be durable and permanently elastic.

To join parts temporarily to check if length of duct or system run is all right.

Lindab Safe

Solution:

- 1 Join together to check.
- 2 Then take apart – and cut if necessary the duct length.
- 3 Join together with screws or blind rivets.

Lindab Safe Click

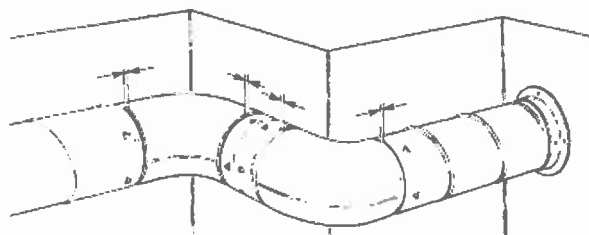
Solution 1:

- 1 Use a duct **without** notches in the end/ends.
- 2 Join together to check.
- 3 Then take apart – and cut if necessary the duct length.
- 4 Make notches in the duct.
- 5 Click-join together.

Solution 2:

- 1 Use a duct **with** notches in the end/ends.
- 2 Join together to check – but don't join the parts completely so they click together.
- 3 Then take apart – and cut if necessary the duct length and make new notches.
- 4 Click-join together.

Lindab Safe Click

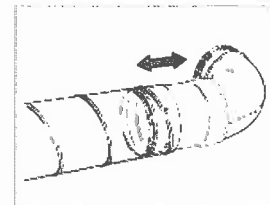
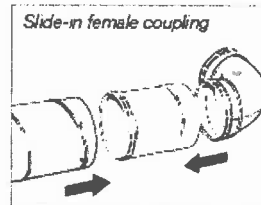
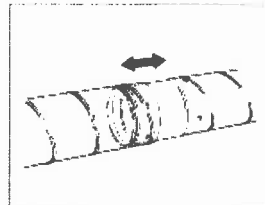
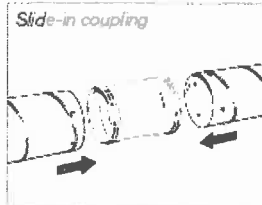


To lengthwise adjust joined products instead of cutting the duct.

Lindab Safe

Solution:

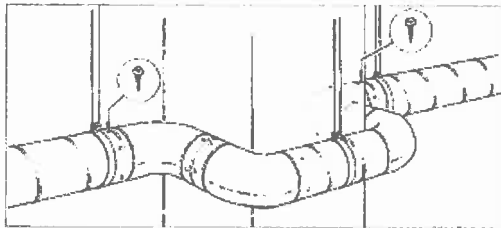
- 1 Use products with sliding property. E.g. slide-in coupling SNPU or slide-in female coupling SMFU.
- 2 Join together with screws or blind rivets.



Solution:

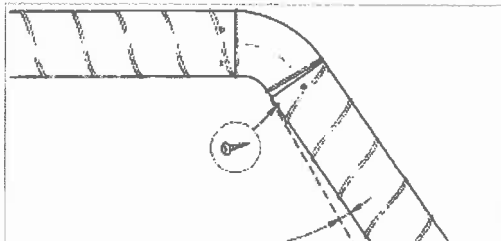
- 1 Use products with sliding property. E.g. slide-in coupling SNPU or slide-in female coupling SMFU.
- 2 Join together with screws or blind rivets.

The joint must be locked



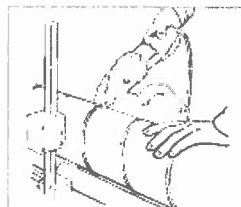
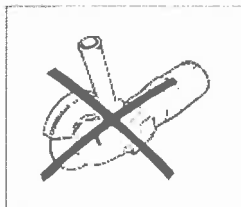
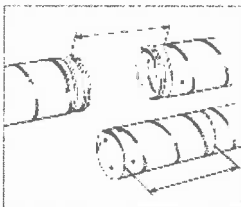
In situations where the mounting must be locked, e.g. when a bend is mounted to a duct and it twists downwards the floor. Mount the first hanger and mount the bend, then lock the joint with a screw or blind rivet.

Corners out of angle and curved walls

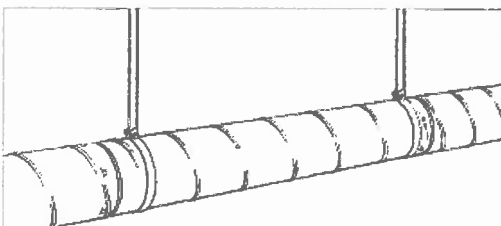


Mount the next piece of duct at an angle, but make sure that the rubber sealant is not visible. Put screws or blind rivets where the notches have not clicked in position.

Cutting duct with the SR Cutter



Suspension



Mount the hangers in a straight line and as close to every joint as possible. Fix with an extra screw when needed for extra stability.

Dismantling

To separate joined products.

Lindab Safe

Solution:

- 1 Unscrew the screws or drill away the blind rivets.
- 2 Twist the product loose.
- 3 The fitting will now have leaking holes but can be reused if these holes are carefully sealed off with mastic or tape.

Lindab Safe Click

Solution:

- 1 Drill a 5 mm hole in the duct 4 mm behind the notch with the drill angled backward and
- 2 turn in the same moment the drill back so the fitting and duct are separated somewhat from each other. With the right technique the fitting remains undamaged and can be reused.
- 3 Repeat if necessary at more notches.
- 4 Twist the product loose.
- 5 Cut away the drilled through duct end.

Lindab Safe Click

