

## Textile Based Ventilation

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# 1. TEXTILE BASED VENTILATION



## AIR THE WAY YOU WANT

Creating a good indoor climate involves more than just selling air distribution products. For us it's all about dialogue, expertise, reliability and logistics. We don't stock finished products or have standard components. All our solutions are tailored to the task at hand. Just as people are different, indoor climate requirements are different, too. What we have done is to specialize in meeting these requirements.



## WE SUPPLY GOOD INDOOR CLIMATE

KE Fibertec AS develops, manufactures, and markets "Good indoor climate" or air distribution systems based on fibre technology and sustainability. The foundation of KE Fibertec goes back to 1963 when Keld Ellentoft (KE) began manufacturing filterbags for industry.

## EXPERTISE AND DEVELOPMENT

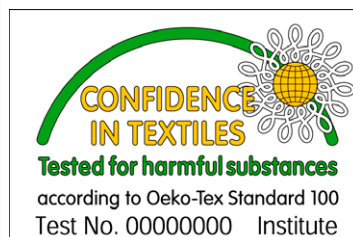
Much has changed since the first TBV system was delivered to a Danish slaughterhouse in the early 1970s. Today we have our own fully equipped full-scale laboratory enabling us to visualize solutions using smoke and to perform tests. It is also possible for us to build a full-scale model of a specific room in order to simulate various load situations. Whatever the scope of the project, our experienced and dedicated R&D staff is ready to document the solution. This also applies for on-site measurements for the end user.



## SUSTAINABILITY AND ENVIRONMENT

Respect for the environment is common sense - and good business. At KE Fibertec we care about the environment and about energy. We want to make as little harm to the environment as possible both in production and in transportation of our products - and at the same time we have launched a number of in-house energy-saving initiatives to limit the CO<sub>2</sub> emission.

To minimize resource requirements and monitor our initiatives the KE Fibertec group carries out an environmental mapping process every third year. With this documentation we are able to determine if our environmental objectives have been reached and define new and ambitious objectives.



KE Fibertec is certified acc. to ISO 9001 (quality), ISO 14001 (environment) and DS/OHSAS 18001 (working environment), and KE Fibertec's textile ducts are manufactured on the basis of Oeko-Tex® Standard 100 certified yarns.

## CSR - WE CARE

KE Fibertec practice Corporate Social Responsibility (CSR) throughout the corporation. We believe that we as a responsible company must show social responsibility by actively involving ourselves in the community and voluntarily contribute to making the world a better place to live in. KE Fibertec respect the UN Global Compact principles which among other things involve human rights, environment, and anti-corruption.

Our employees are KE Fibertec's greatest asset, and therefore we prioritize their well-being in relation to their safety, health, and environment. The company is certified according to the ISO 18001 Standard that ensures a good working environment. Further, we focus on the personal and professional development of every single employee.

## FROM FIBRE TO FINISHED FABRIC

KE Fibertec is the only manufacturer in the world which weaves all fabrics used for our ducts in our own weaving mill, KE Fibertec Væveri AS. This is the only way that we can ensure that the materials have been tested and meet the stringent quality requirements we set:

- the air must pass through properly (uniformly through the whole fabric)
- the fabric's structure must provide the largest surface area (large dust holding capacity)
- the shrinkage rate after washing must be less than 0.5%
- the materials must stand up to repeated washing and tumble-drying
- the finished materials must be fire-approved (not just the fibre).



KE Fibertec Væveri manufactures more than 40 different product varieties from Trevira CS polyester materials woven in 10 different permeabilities and in different colours, to antistatic materials and Nomex special blends. All materials are heat-treated, transilluminated

[ke-fibertec.com/weavingmill](http://ke-fibertec.com/weavingmill)

and tested at the weaving mill. When they have been approved a bar code is affixed to them displaying

information about the weaving machine, permeability and production date. All this information guarantees complete electronic traceability for all products from fibre to finished TBV system.

## CRADLEVENT®

CradleVent is the first ventilation duct in the world to receive the Cradle to Cradle approval by the EPEA Institute in Hamburg, Germany. The certification documents the sustainability of the product and the fact that we take responsibility of its life cycle from Cradle to Cradle, ie. from production to recycling. CradleVent is our contribution to a proactive and sustainable product for air distribution in office buildings, schools, laboratories, sports arenas, public buildings, and other comfort zones. Read more about CradleVent® in chapter 3.





## INTEX®

The new Danish building code BR 2020 focuses on energy consumption. Among other things this will involve energy limitations for offices, schools, institutions, etc. limiting the kWh/m<sup>2</sup> to a third of the present level.

Therefore KE Fibertec developed InTex® - a sensor that is attached to the textile duct allowing us to monitor when the duct is blocked by dust and dirt, and consuming excessive power. A clean textile duct will distribute the same volume of air using less power. This is not only good for the environment but also for the business resulting in cost savings on the running of the system. Read more about InTex® in chapter 17.



## KE FIBERTEC WORLDWIDE

Today the KE Fibertec Group is represented all over the world and employs more than 110 people, the majority working in our five sales subsidiaries in the UK, Germany, the USA and Turkey as well as Euro Air A/S. Furthermore, the group runs two production companies, KE Fibertec Væveri (weaving mill) and Euro Air CZ.

With the acquisition of our competitor, Euro Air A/S and Euro Air CZ in September 2007, the KE Group has consolidated its position as the world's largest manufacturer of textile ducting.

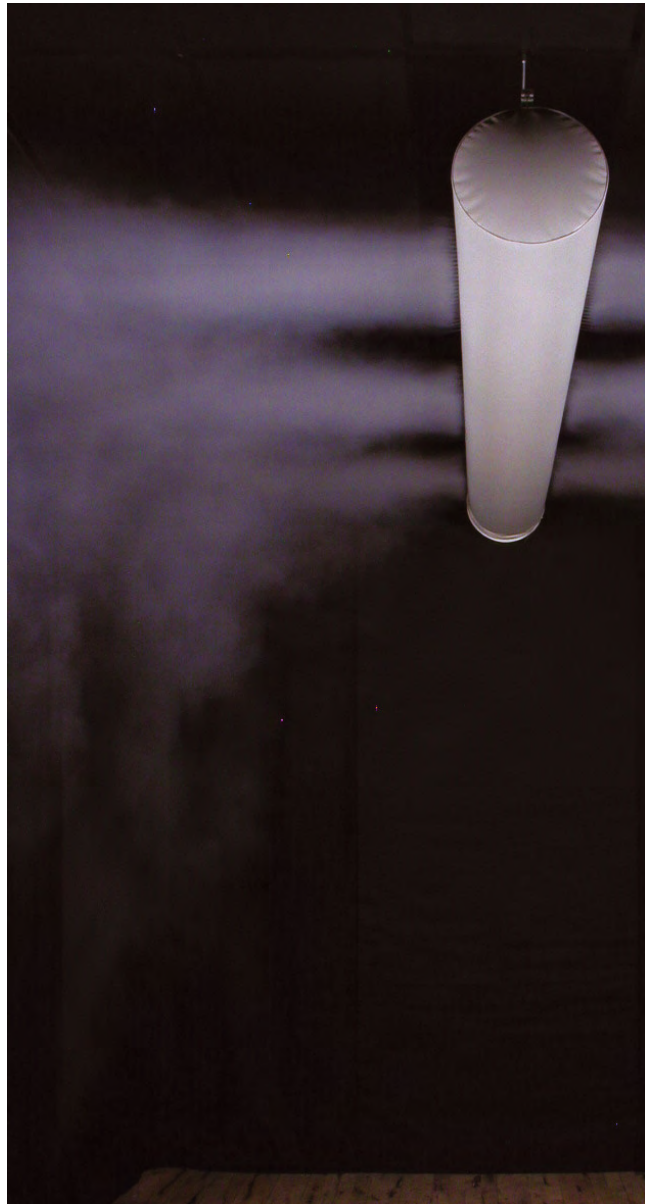


## LOGISTICS THAT WORK

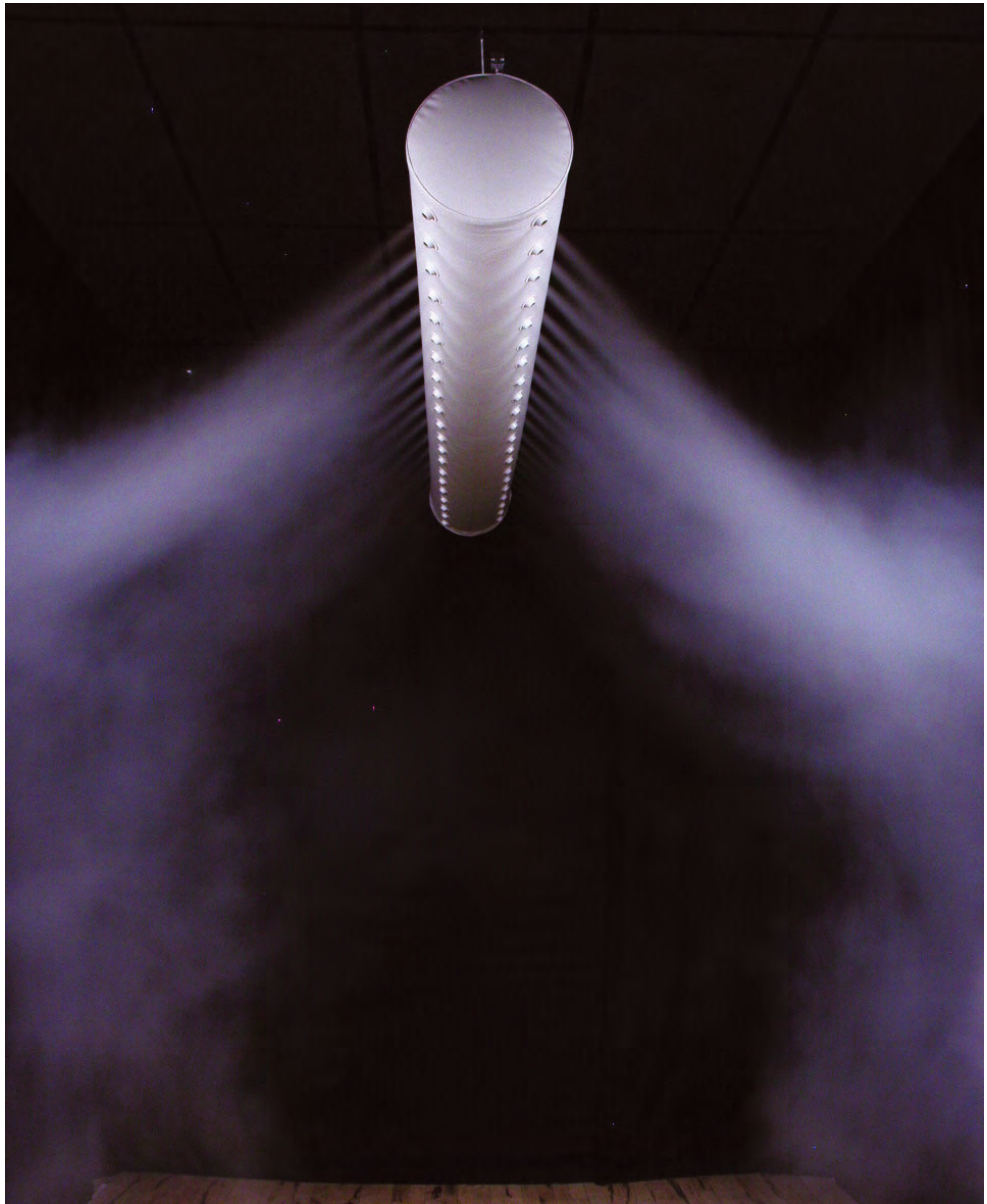
Time is money. So we understand the importance of rapid, accurate delivery to the construction site. Good cooperation is based on trust and understanding. We are very proud of the fact that we can justify your trust as we guarantee meeting 99% of “just in time” delivery times, even though all our products are manufactured to order. Our typical turnaround time from order confirmation to delivery is 10-15 working days, depending on the time of year and the order’s complexity. We can, of course, respond more quickly to rush orders or part deliveries to every destination in Western Europe and the United States. You just need to remember to ask for our express delivery service “Fast Line”. If you want to reorder a product from a previously delivered order, remember that all KE products are fitted with a label that can help us to identify the order.

Thanks to the experience gained from more than 40 years in the business, we feel well prepared to supply you with your next order.





## 2. PRODUCT RANGE

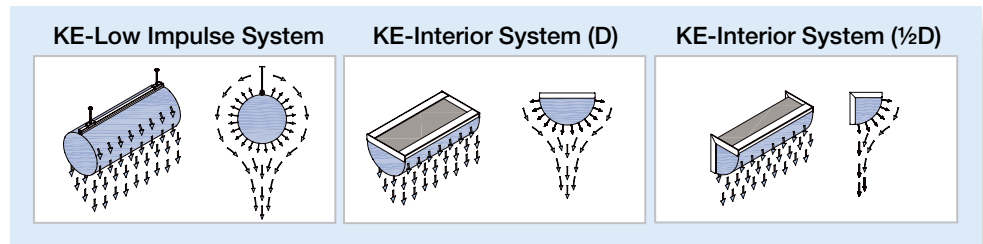


# PRODUCT RANGE

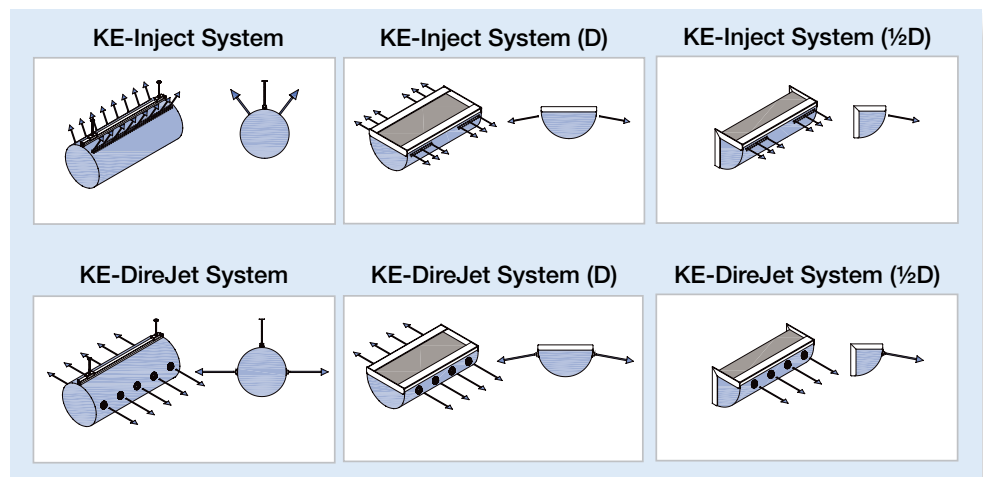
## MAIN PRODUCTS

KE Fibertec develops and markets three main TBV product groups, which can all be supplied in three different geometries. In passive low impulse systems the air diffuses through a permeable material. In high impulse systems air is distributed solely through holes (KE-Inject System) or nozzles (KE-DireJet System). The hybrid models are a combination of the passive low impulse systems and the lasered Inject holes or DireJet nozzles. You can read more about these products and how they work in chapters 6, 7 and 8.

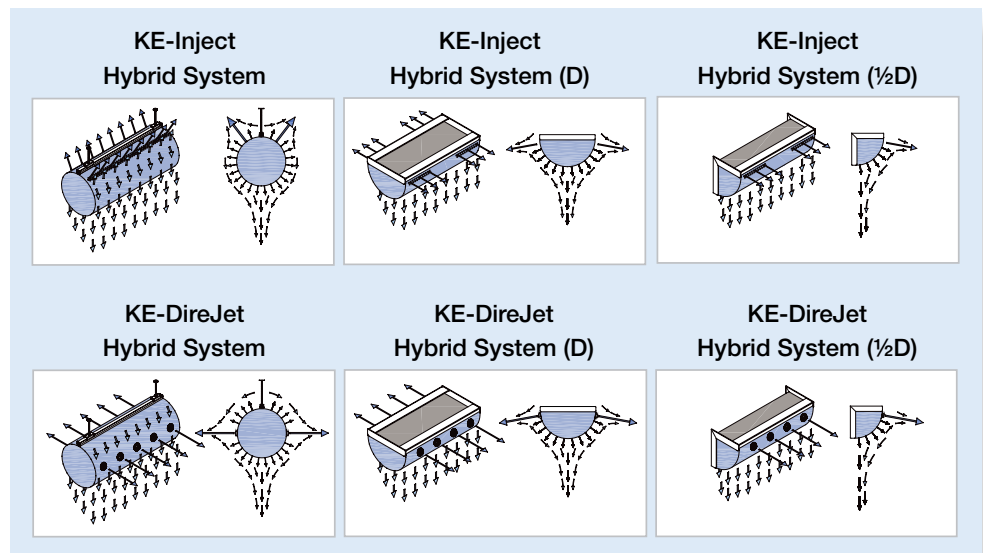
## PRODUCT RANGE: LOW IMPULSE SYSTEMS



## PRODUCT RANGE: HIGH IMPULSE SYSTEMS



## PRODUCT RANGE: HYBRID HIGH IMPULSE SYSTEMS



LOW IMPULSE SYSTEMS

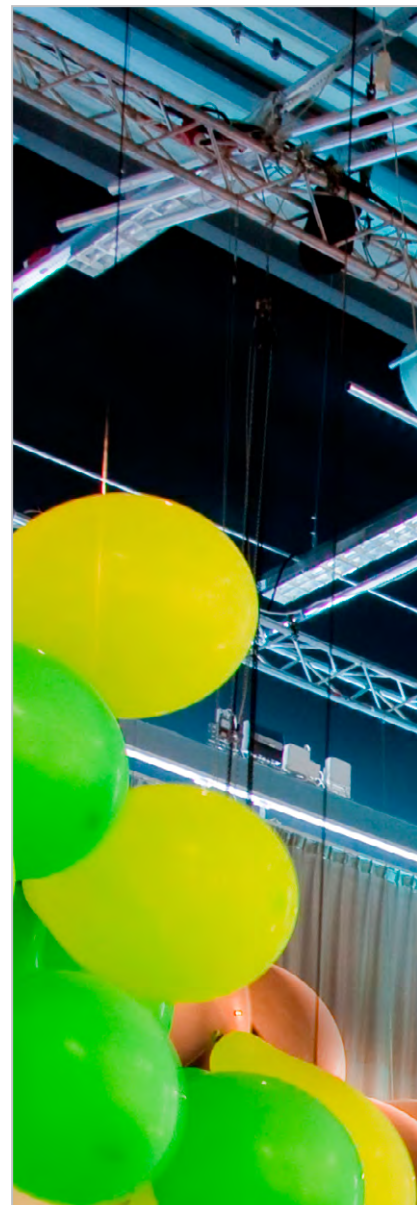


HIGH IMPULSE SYSTEMS



HYBRID HIGH IMPULSE SYSTEMS

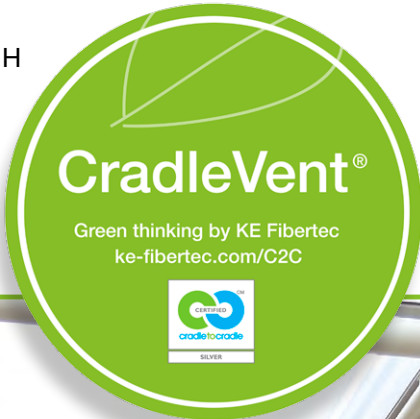




### 3. CRADLEVENT®



NEW ARCHITECTURAL POSSIBILITIES WITH  
CRADLE TO CRADLE TEXTILE DUCTING



CRADLE TO CRADLE IS DOCUMENTED  
SUSTAINABILITY

CradleVent® is the first ventilation duct in the world to receive the Cradle to Cradle approval by the EPEA Institute in Hamburg, Germany. The certification documents the sustainability of the product and the fact that we take responsibility of its life cycle from Cradle to Cradle, ie. from production to recycling.

SUSTAINABLE VENTILATION

CradleVent® is our contribution to a proactive and sustainable product for air distribution in office buildings, schools, laboratories, sports arenas, public buildings, and other comfort zones.



## WASTE = FOOD

The increasing shortage of natural resources such as steel, copper, and oil makes it necessary to recycle instead of throwing away.

In the Cradle to Cradle concept you see waste as food for a new production which creates balance in the cycle. When the product is no longer usable we take it back for disassembly and recycle what we can in a new technical cycle.

In this way nothing is wasted. This results in more proactive and sustainable products that are not harmful to the environment.



[ke-fibertec.com/C2C](http://ke-fibertec.com/C2C)



### CASE

Cradle to Cradle school ventilation in Holland  
Read more at [ke-fibertec.com](http://ke-fibertec.com)



## 4. WHERE OUR PRODUCTS ARE USED



## REFERENCES

Textile ducting can be used in almost any type of installation and building, irrespective of whether the requirement is for heating, cooling, ventilation or a replacement air system. Over the years, KE Fibertec and its partners have accumulated a large database of references covering every possible installation and we can safely guarantee that we have a solution to suit your enquiry. You will find a number of references at [ke-fibertec.com](http://ke-fibertec.com).

## WHY CHOOSE TEXTILE BASED VENTILATION?

Flexibility and tailored products are the hallmark of our TBV solutions. This allows you to freely choose the size that best suits your design rather than having to be tied to a particular number of standard solutions. In addition to this, the options offered when it comes to selecting system layouts, colours, offsets, elbows, sockets and materials are endless, not to mention that you can choose whether the TBV system will be passive (low impulse), semi-active (hybrid) or active (high impulse). In a nutshell, there could not be more options available for achieving optimum air distribution.

### UNIQUE MATERIALS

Our textiles are produced at our own weaving mill with the sole purpose of offering the most suitable materials for air distribution in the market. The selection of fibres, weight, weaving technology, dyed yarns and heat treatment are based on our desire to achieve totally uniform air permeability, a large dust holding capacity, the lowest possible shrinkage after washing and basic colours without any additional cost.

### EFFICIENT AIR DISTRIBUTION AND GOOD INDOOR CLIMATE

Textile ducts are very well-suited for efficient, uniform, and draught-free distribution of fresh air without "dead zones". Stale and stagnant air may cause fatigue and headache. KE Fibertec's textile ducts create an effective air change and a good indoor climate in schools, offices, shops, showrooms, and other types of rooms where many people are assembled.

### EASY TO TRANSPORT AND INSTALL

Our materials weigh 260-330 g/m<sup>2</sup> which is much lighter than metal spiral ducts. Additionally, textile ducts are much easier to handle and transport as they are folded and packed in cartons of a maximum weight of 25 kg. KE Fibertec's suspension rails are delivered in exact lengths rendering installation easier and quicker than for similar systems.

### FIRE APPROVED MATERIALS

Naturally, all KE Fibertec materials have been fire-tested and approved according to international fire standards incl. EN 13501-1.

### HYGIENIC AND EASY TO MAINTAIN

All TBV systems can easily be taken down and washed in a washing machine. The specially treated Trevira CS materials absorb no more than 1% of water, even with a relative humidity of over 90%. This is why their use is approved in the food industry. In extremely humid environments you may choose an anti-microbial treatment that make the textile ducts resistant to mould and microorganisms. Please, note that this treatment will be rendered ineffective at humidity levels below 85% RH.

### SUSTAINABLE VENTILATION

All KE Fibertec textile ducts are based on Oeko-Tex® Standard 100 certified yarns. Our production is certified according to the ISO 14001 standard (Environment). Transportation and disposal of textile duct systems produce less CO<sub>2</sub> pollutants than conventional steel ducts.

CradleVent® is the world's first Cradle to Cradle ventilation duct for sustainable building. With textile ducts you can create a more efficient air distribution compared to steel ducts which allows for energy savings.

## THE HISTORY OF TBV

Initially, TBV meant a simple duct designed for slaughterhouses for the delivery and distribution of very high quantities of cold air into the occupied zone with minimal draught in order to improve working conditions. Back in the early 70's the appearance of ducts was not an issue - only the function. At first it was just a simple "bag" made of cotton attached to the end of a cooler or grille that would inflate and slowly let the air out.

Soon alternative materials replaced cotton as it - being an organic material - was found to absorb water and promote bacterial growth. The use of man-made polyester fibres was the next step very soon followed by fire rated materials such as Trevira CS®.

Over the years, the ways of distributing the air in a room have changed - from simple material diffusion to applying nozzles and holes to distribute warm and cold air. This was a natural development since the segment today not only applies to cold rooms but also to high demand comfort rooms such as offices and schools.

## FROM 1974 TO THE PRESENT



1974

First textile duct installed in Danish slaughterhouse. 1st generation made of cotton



1978

Textile ducts made of Polypropylene



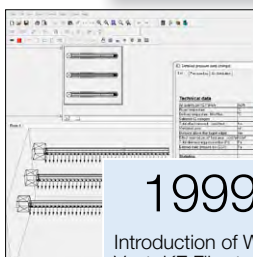
1989

Textile ducts made of 100% polyester



1993

KE Fibertec develops and patents the KE-Inject® LV system - first TBV system for heating



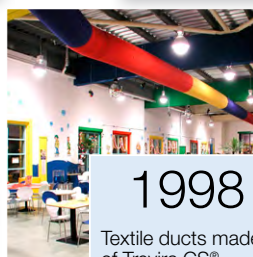
1999

Introduction of WinVent, KE Fibertec's 3D design software



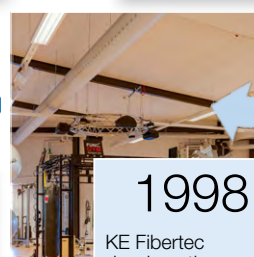
1999

KE Fibertec purchases own weaving mill, KE Fibertec Væveri AS



1998

Textile ducts made of Trevira CS® Polyester



1998

KE Fibertec develops the DireJet® nozzle for directional air distribution



2000

KE Fibertec introduces textile ducts with laser-cut holes



2008

KE Fibertec develops the Vario nozzle



2012

Sustainability with CradleVent® textile ducts



2014

KE Fibertec develops the intelligent textile duct - InTex®

## PRODUCT PRICE

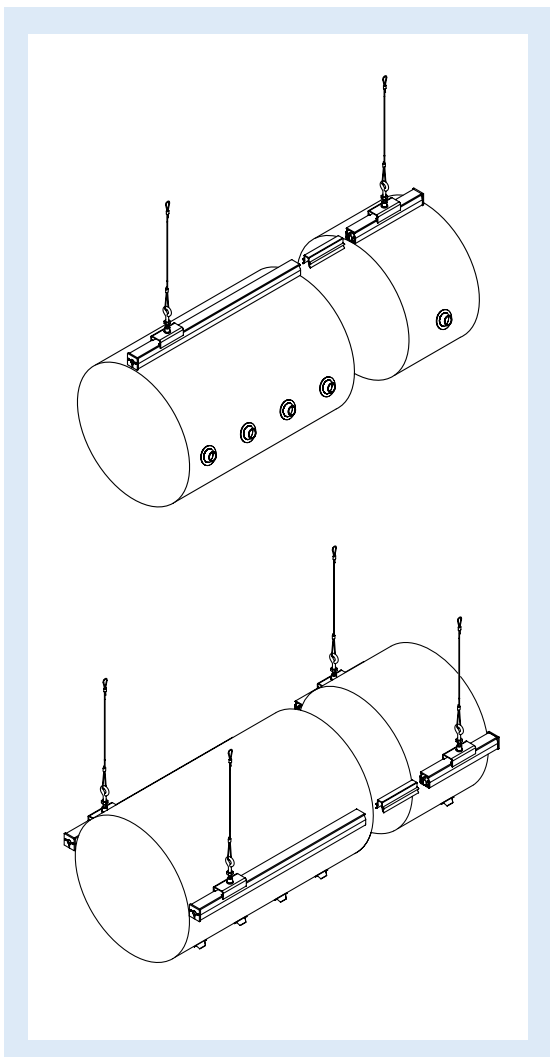
The actual product price depends mainly on the size of the system, as well as the products and material chosen. The product price per metre of ducting will be much cheaper, the bigger the project is. For instance, a TBV duct for distributing 1,000 m<sup>3</sup>/h of air costs significantly more per metre of ducting than a TBV system for distributing 10,000 m<sup>3</sup>/h of air.

The most expensive products in our range are ½D and D-shaped systems, which should mainly be chosen if appearance and product finish are important requirements.

The actual textile material used also plays an absolutely crucial role in the product price. KE Fibertec offers fire-approved Trevira CS textiles as standard, which comply with all the general national fire requirements. These specially treated materials also offer value for money thanks to their highly uniform air permeability, which is beneficial to pressure loss and energy consumption. Textile ducting must be able to stand up to being repeatedly washed without losing its shape, shrinking or losing its colour. We guarantee that our materials are manufactured for long-term use, even if they are washed regularly.

## INSTALLATION PRICE

Round ducts are generally cheaper to install than D or ½D-shaped ducts. We recommend using a rail solution rather than wire, even though this adds to the product price. Rails are always supplied cut to size and clearly labelled as to where they need to be installed. This makes the installation process much quicker, and very often considerable savings can be made with the installation of a KE Fibertec TBV system, compared with a conventional system. Handling the heavy metal ducts, which includes adjusting the lengths, assembling the fittings etc., at the construction site is extremely time-consuming. When a TBV system is selected, all the lengths, elbows, offsets etc. are delivered ready to be joined together with a zipper. The only requirement is that accurate field verification takes place before the project is released for manufacture.



## MAINTENANCE

New Danish ventilation regulations increasingly focus on energy efficiency. The updated standard DS 447 specifies how to limit power consumption of ventilation without compromising the indoor climate.

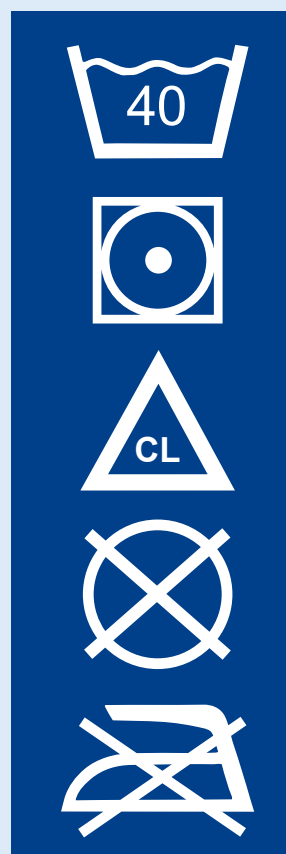
All ventilation ducts must be cleaned at some point in order to ensure effective and draught-free air distribution with steel based ventilation systems (SBV) being no exception. However, cleaning of steel ducts is both costly and difficult which means that most SBVs are not being cleaned, resulting in reduced performance, loss of energy and poor indoor climate. In order to establish exactly when the textile duct requires washing, KE Fibertec has developed InTex® - an intelligent system for monitoring the air pressure of the duct. Read more about InTex® in chapter 17.

Textile ducts can be easily taken down and washed in a regular washing-machine. Washing intervals of textile ducts depend on several factors such as application, location, pre-filter, etc., however, most importantly the material plays a major part in this. Read more about materials in chapter 13.

The key parameters which influence how often the systems are washed are as follows:

- Air quality, including the pre-filter's quality. In low impulse systems we recommend F7 pre-filters for supply air. Remember that there is a big difference in pre-filter quality.
- The system's annual operating time in hours.
- The air volume per m<sup>2</sup> of textile surface. The greater the load per surface area, the more frequently the system needs to be cleaned.
- The textile's dust holding capacity (DHC). An ordinary standard fabric often only has half the DHC of a KE Fibertec fabric and it costs a great deal in unnecessary maintenance. A hybrid system with laser cut holes or DireJet nozzles has longer wash intervals than a standard low impulse system.
- Hygiene requirements. There may be absolutely specific hygiene requirements determining how frequently the system must be washed, for instance, in the food industry. The usual frequency for washing is calculated as once a year, regardless of how dirty the TBV ducting actually is.

” All ventilation ducts must be cleaned inside and outside at some point. It is simply not true that all TBV systems get clogged up within a year. For example, high impulse systems do not require any more maintenance than metal spiral ducting.”



# WHERE OUR PRODUCTS ARE USED



[ke-fibertec.com/dssm](http://ke-fibertec.com/dssm)

## CASES

On several occasions KE Fibertec has been able to help customers create savings on their total energy consumption, naturally without compromising comfort demands. The sooner we are included in the project, the better solution we can offer that will meet the demands of the contractor. Read more in chapter 5, From Dialogue to Solution.

### DS SM A/S, DENMARK

KE Fibertec has supplied the air distribution system for the Danish steel production company DS SM's new state-of-the-art surface treatment plant. Their energy consumption was reduced by 30-50% compared with similar production plants. Scan the QR code to read the case or go to [ke-fibertec.com/dssm](http://ke-fibertec.com/dssm).

### ZWEMBAD DE VIERGANG TE PIJNACKER

The Dutch consultant on this project was looking for a ventilation system for swimming pool areas that would create optimum indoor climate and reduce energy consumption. In cooperation with our Dutch partner, KE Fibertec Benelux B.V., the existing steel ducts were replaced by textile ducts which not only improve indoor climate but also result in energy savings of up to 25%. Read the case at [ke-fibertec.com/zwembadcase](http://ke-fibertec.com/zwembadcase).

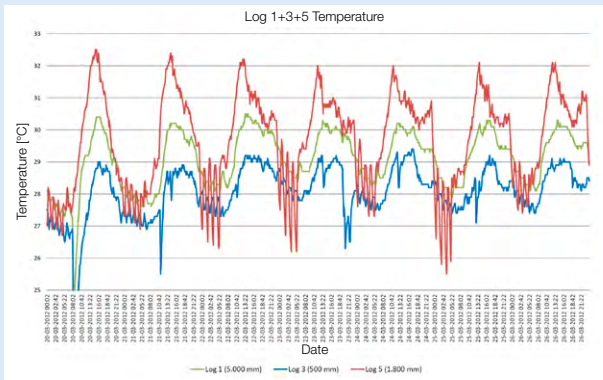
#### FACTS:

Contractor:	Zwembad De Viergang te Pijnacker
Consultant:	Maarten Uiterwijk, Sportfondsen Nederland N.V.
Installer:	KE Fibertec Benelux B.V.
Year of construction:	2012
Air volume:	27.500 m <sup>3</sup> /h
KE System:	KE-InJect®
Outer ring:	Ø710-Ø450 mm, 132.7 m duct
Inner ring:	Ø450 mm, 61.6 m duct

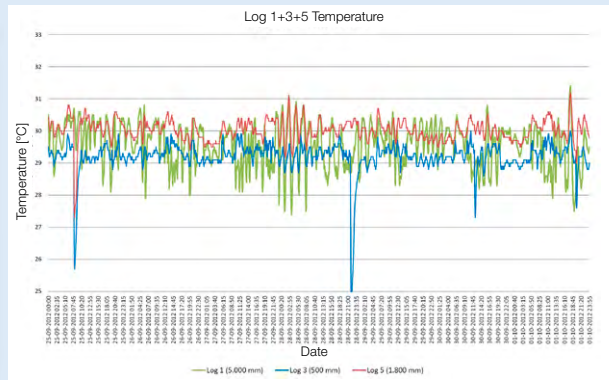


## TEMPERATURE

The SBV system had huge problems keeping the room temperature above the water temperature in order to prevent evaporation of pool water.



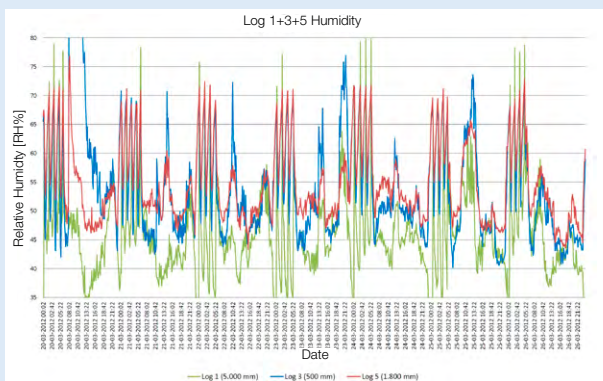
Old steel based ventilation layout (SBV)



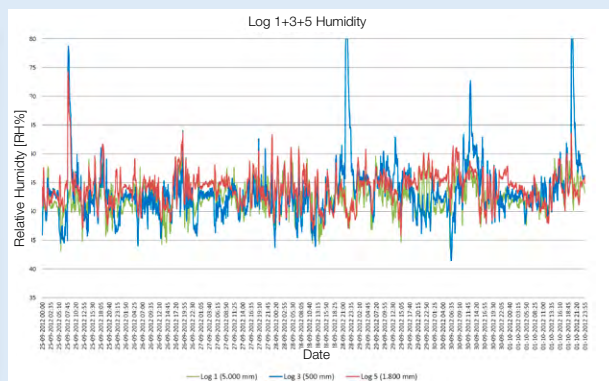
New textile based ventilation layout (TBV)

## HUMIDITY

The SBV system also had huge problems keeping the humidity in the room between the acceptable 50-60% RH. If the humidity is too high, it will not only be uncomfortable for the users (swimmers) but will also harm the building construction, and most likely mould and corrosion will occur. Too low humidity becomes an issue in terms of energy.



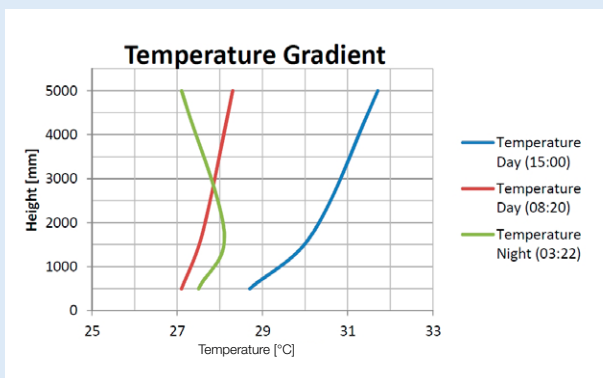
Old steel based ventilation layout (SBV)



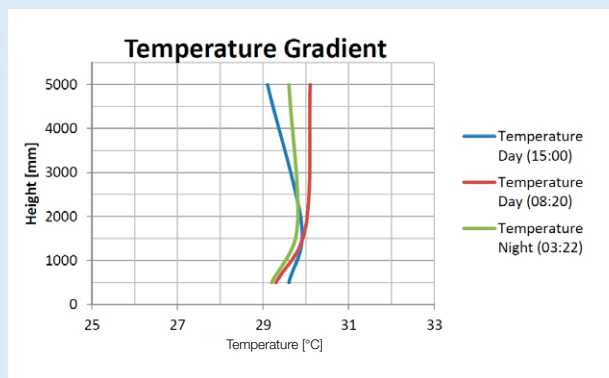
New textile based ventilation layout (TBV)

## VERTICAL TEMPERATURE GRADIENT

In the course of 24 hours the SBV system has a high vertical temperature gradient, rising from 27.5°C to 30.5°C - a change of 3°C whereas the TBV system has a very low vertical temperature gradient of only 0.5°C and constantly stays above the pool water temperature of 29°C.



Old steel based ventilation layout (SBV)

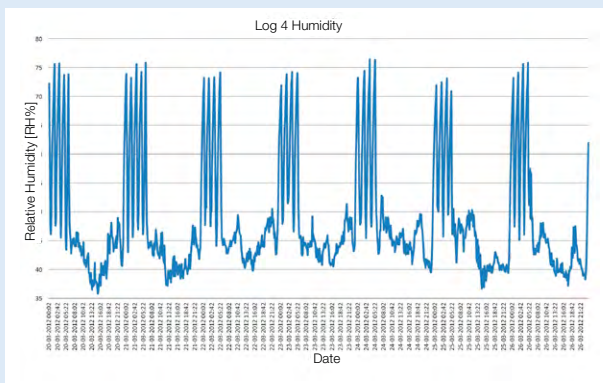


New textile based ventilation layout (TBV)

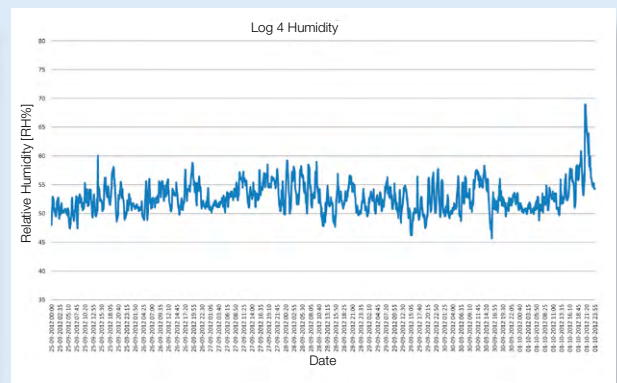
## CONDITIONS AT WINDOWS

Upon installation of the new TBV system no condensation could be found at the windows. According to the logging data of the SBV system condensation problems were to be expected during the winter. With the SBV system the relative humidity at the windows was approx. 5% higher than at the centre of the room, however, with the TBV system humidity was almost the same as at the centre of the room. At  $-5^{\circ}\text{C}$  outside temperature the humidity must be below 60% RH to prevent condensation, otherwise the windows have to be heated by warm and dry air in a separate heating system.

Below charts show that the relative humidity of the TBV system is below 60% RH around the clock, whereas the SBV system was above 75% RH causing major problems of condensation at the windows. Solving this problem was of decisive importance for choosing a textile based ventilation system.



Old steel based ventilation layout (SBV)



New textile based ventilation layout (TBV)



























## GUIDE TO SELECTING THE BEST AIR DISTRIBUTION SYSTEM

In the following section we have created a product chart based on type of application matched with the best product choice. The approach taken when the charts were built was how to generate “added value or the best possible value for money”. However, other products can also be used for a particular installation if the assessment is based on other requirements.



[ke-fibertec.com/productguide](http://ke-fibertec.com/productguide)

Application:	Recommended system:	Ventilation type:
 <p>Comfort</p>	<p>KE Low Impulse System  </p> <p>KE Interior  </p> <p>CradleVent®  </p>	<p>Low impulse ventilation /                      Displacement ventilation</p> <p>Hybrid ventilation</p>
 <p>Showrooms</p>	<p>KE Inject Hybrid System  </p> <p>KE DireJet  </p> <p>CradleVent®  </p>	<p>Mixing ventilation</p> <p>Hybrid ventilation</p>
 <p>Laboratories</p>	<p>KE Low Impulse System  </p> <p>KE Interior  </p> <p>CradleVent®  </p>	<p>Low impulse ventilation /                      Displacement ventilation</p> <p>Hybrid ventilation</p>
 <p>Sports &amp; Leisure</p>	<p>KE Inject Hybrid System  </p> <p>KE DireJet  </p> <p>CradleVent®  </p>	<p>Mixing ventilation</p>
 <p>Industry</p>	<p>KE Low Impulse System  </p> <p>KE DireJet  </p> <p>KE Inject Hybrid System  </p>	<p>Low impulse ventilation /                      Displacement ventilation</p> <p>Hybrid ventilation</p> <p>Mixing ventilation</p>
 <p>Food Industry</p>	<p>KE Interior  </p> <p>KE DireJet  </p> <p>KE Low Impulse System  </p>	<p>Low impulse ventilation /                      Displacement ventilation</p> <p>Hybrid ventilation</p> <p>Mixing ventilation</p>

# WHERE OUR PRODUCTS ARE USED

## KE REFERENCES FOR COMFORT VENTILATION OFFICES, CANTEENS, SCHOOLS, CHILD CARE FACILITIES, LECTURE HALLS



*Broomfield Hospital, UK*



*Guldfågeln Arena, Sweden*



*Walkden High School, UK*



*Swedbank, Sweden*



*Zeile Kältetechnik, Germany*



*Hull University Business School, UK*

To see more references, visit [www.ke-fibertec.com](http://www.ke-fibertec.com)

KE REFERENCES FOR SHOWROOMS/PUBLIC BUILDINGS  
SHOWROOMS, SUPERMARKETS, STORES, RESTAURANTS, ATRIUMS, EXHIBITION CENTRES



*National Museum, Norway*



*Leicester Service Station, UK*



*Four Rivers Harley Davidson, USA*



*Bel Air Aviation, Denmark*



*Konst och Länsmuseum, Sweden*



*IKEA Älmhult, Sweden*

To see more references, visit [www.ke-fibertec.com](http://www.ke-fibertec.com)

# WHERE OUR PRODUCTS ARE USED

## KEY REFERENCES FOR LABORATORIES PRODUCTION, CLEAN ROOM LABORATORIES



*Astra-Zeneca, UK*



*Intertek, Holland*



*Laboratory: Southampton University, UK*



*Clean room facility: Alcon Ireland, Ireland*



*Laboratory: Pfizer, Sittingbourne Research Centre, UK*



*Laboratory: Boots Pharmaceuticals (Strepsils), UK*

To see more references, visit [www.ke-fibertec.com](http://www.ke-fibertec.com)

KE REFERENCES FOR SPORTS/LEISURE  
SWIMMING POOLS, SPORTS ARENAS, FITNESS STUDIOS



*Ocean Spa Essex, UK*



*Basildon Sporting Village, UK (2012 Olympics)*



*Skating rink: Thialf Heerenveen, Holland*



*Sports centre: Skjern Bank Arena, Denmark*



*Fitness: Friskis & Svettis, Sweden*



*Fitness: Rosvalla Arena, Sweden*

To see more references, visit [www.ke-fibertec.com](http://www.ke-fibertec.com)

# WHERE OUR PRODUCTS ARE USED

## KE REFERENCES FOR INDUSTRIAL VENTILATION

PRODUCTION PREMISES, STORAGE ROOMS, PRINTING WORKS, VEHICLE WORKSHOPS



*Jorgensen Engineering, Denmark*



*Printing works: Plantijn Casparie, Holland*



*WILO SE, Germany*



*Lohmann Tapes, UK*



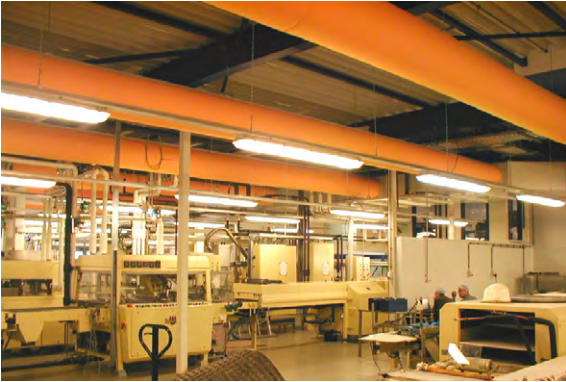
*DS SM, Denmark*



*Kamstrup, Denmark*

To see more references, visit [www.ke-fibertec.com](http://www.ke-fibertec.com)

KE REFERENCES FOR INDUSTRIAL REFRIGERATION  
EQUALISING ROOMS, SLICING ROOMS, WAREHOUSES, FOOD TERMINALS



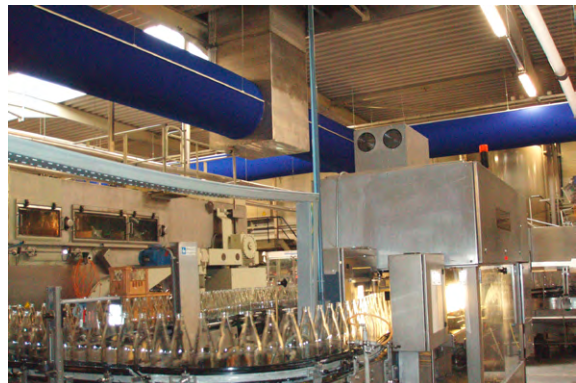
*Food production: Baronie Chocolate, Holland*



*Process cooling: Danish Crown, Denmark*



*Cold store: Unilever, Sweden*



*Food production: Ordal Bronwater, Belgium*



*Food terminal: Arla Foods, Sweden*



*Process cooling: Dalehead Foods, Bury St. Edmunds, UK*

To see more references, visit [www.ke-fibertec.com](http://www.ke-fibertec.com)



## 5. FROM DIALOGUE TO SOLUTION



## REQUIREMENTS AND EXPECTATIONS

“KE Fibertec designs solutions for a given installation, based on the parameters which we have determined through dialogue – solutions that also work in practice. This is why you shouldn't be surprised when we ask an array of questions right at the quotation phase, both about the ventilation system and also about the end user's needs and requirements.”

KE Fibertec's well-trained team of sales engineers have the tools available to offer an enhanced design service, which can help you find the perfect ventilation solution. Even at the quotation stage we think it is very important to establish a good dialogue. Dialogue can help us identify and formulate the task so that we can guarantee that the TBV solution provided will meet the end user's requirements and your expectations of the end result.

## ALL SOLUTIONS ARE TAILORED EXACTLY

KE Fibertec has developed a number of tools and services which our customers can choose to use throughout the entire project process. Our services are graded so that customers can decide themselves which ones they do and don't want. Our opinion is that no two jobs are the same and no solution is standard. Consequently, the documentation and level of detail need to be adapted to the requirement and each individual project. Our service can be split into two categories:

1. QUOTATION AND DESIGN
2. EXTENDED PROJECT DOCUMENTATION



## QUOTATION AND DESIGN PROCESSES

KE Fibertec offers advice and support from our experienced in-house sales engineers, who have all undergone extensive training on ventilation products and particularly on our TBV products. All the calculations are proven using our unique software WinVent 3D, which is offered to all our customers, regardless of the size of their project and, of course, free of charge.

Our quotation and design processes are described in detail in our ISO 9001 quality assurance system. This ensures that we prepare the basis for the quotation and the quotation itself according to the standardised guidelines, making sure that the customer's requirements are specified and documented in sufficient detail.

KE Fibertec puts large emphasis on ensuring that the final solution is designed correctly even at the quotation stage. After all, it is not only about ensuring that the textile based ventilation system works properly, but also, to just as large extent, that the customer's indoor climate requirements have been met. This is why we ask about the system's functional requirements and the requirements for the indoor climate at the quotation stage.

**GUIDELINE TO TECHNICAL QUESTIONNAIRE**  
- HELP US OFFERING VALUE FOR MONEY!

KE Fibertec offer an extended design service by our committed and experienced engineers. It is able to provide you with the best possible solution, we need your input. Please read the enclosed guideline and technical questionnaire carefully and send it back to us.

**Your customers problem? (e.g. cooling down the entire room or just zone cooling?)**  
We need to identify the main reason for installing Textile Based Ventilation (TBV). End user expectations is very essential in order for us to suggest the right solution. It is the purpose to create a high degree of comfort for the employees, food or similar product related cooling / heating, or is it replacement of air. Please notice that information about big heat sources, like machinery is very important.

**Is the application going to be used for ventilation / cooling / heating or a combination?**  
This allows to select the best TBV products solving your problem.

**Type of application / room - where are you going to use the ducts?**  
The more specific information about the application the more location oriented design we can provide. We can include reference photos from similar installations and we can use our long experience to make the most cost efficient system.

**Room dimensions, temperatures and air quantities:**  
This information is essential to make a quotation. The most important piece of information is the air quantity as this for instance determines the duct diameter and material characteristics. It is important that the supply temperature is the temperature after the air handles, and that the external static pressure available for the TBV-system is stated.

**Level of activity?**  
We aim to keep their velocity in the occupied zone (1,8m over the floor) at an acceptable level corresponding to the level of activity.

**Mounting height and type of air supply?**  
This helps us make an accurate calculation of air distribution and define a TBV-system tailored to the system of the customer.

**Diagram 1:** A 3D schematic showing a duct with a delivery temperature, air quantity, and distance. It also indicates available static pressure (ES) and shows the duct's position relative to the room height and floor level.

**Diagram 2:** A 3D schematic showing a duct with a delivery temperature, air quantity, and distance. It also indicates available static pressure (ES) and shows the duct's position relative to the room height and floor level.

Our quotation is based on the following information:

- Air volumes (possibly partial air volumes per socket) [m<sup>3</sup>/h]
- Temperature-set cooling and possibly heating [°C]
- Pressure available from the fan [Pa]
- Dimensions of the room L x W x H [m<sup>3</sup>]
- Location of the air inlet(s)
- Requirements in terms of number of ducts and maximum duct dimensions
- Requirements in terms of the room's use (room category)
- Requirements in terms of the maximum permissible air velocity in the room [m/s]
- Requirements in terms of the temperature in the room [°C]
- Requirements in terms of the maximum sound pressure level in the room [dB(A)]
- Selection of duct colours
- Selection of suspension type

”KE Fibertec puts large emphasis on ensuring that the final solution is designed correctly even at the quotation stage. After all, it is not only about ensuring that the textile based ventilation system works properly, but also, to just as large extent, that the customer's indoor climate requirements have been met.”

Given that an infinite number of combinations of system solutions and layout features can be designed for textile based ventilation, it is important that its function is specified precisely at the quotation stage. In our role as consultants, we always endeavour to meet the relevant need with the solution that we have agreed with the customer to offer.

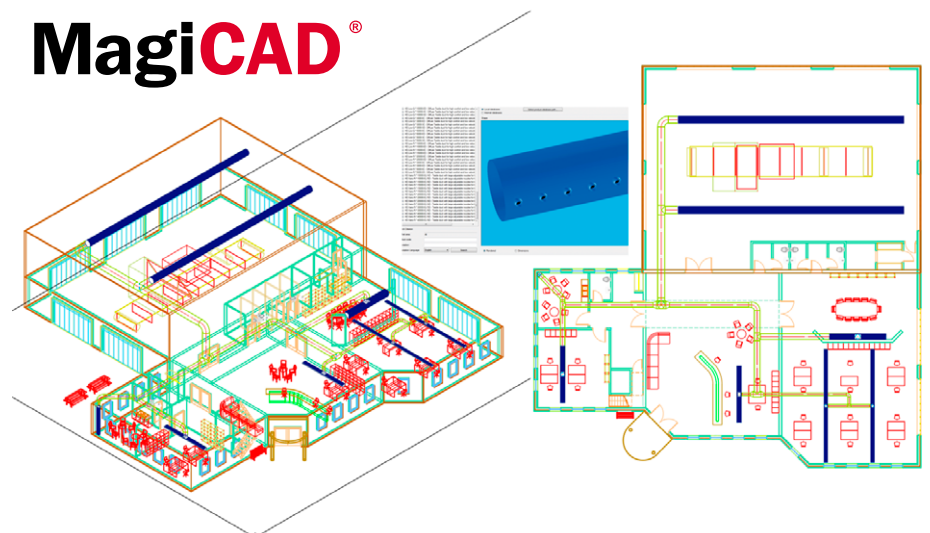
We are highly innovative in our way of thinking, which is why you must not always expect just a “plain” solution which ultimately cannot meet the requirements you set in terms of the system's appearance and the indoor climate. For the same reason our solution is based on the concept “AIR THE WAY YOU WANT”.



## MAGICAD®

Already, many consulting engineers and contractors have discovered MagiCAD to design of ventilation solutions. KE Fibertec is also represented in MagiCAD's database of more than 1,200 units.

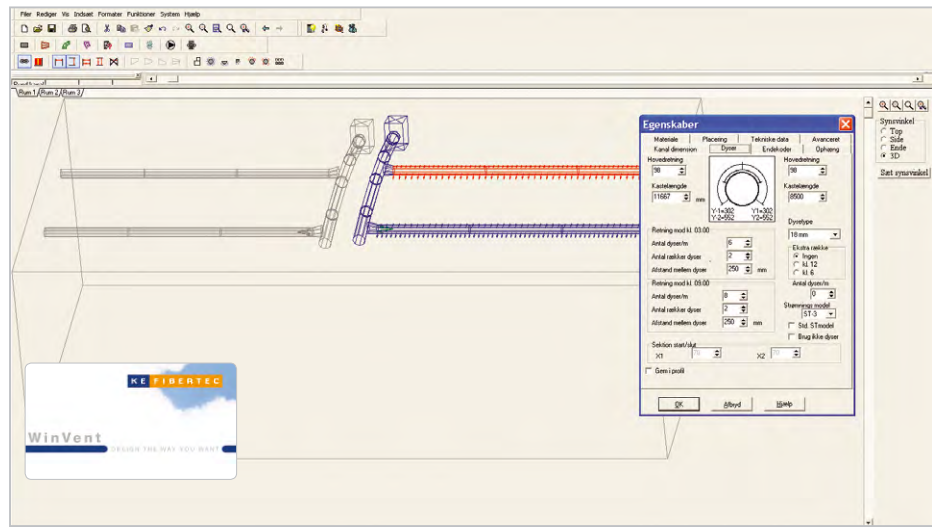
As the first manufacturer of Textile Based Ventilation ducts, KE Fibertec is now ready with a product database that helps engineers design and calculate textile ducts directly in MagiCAD.



” WinVent 3D is an object-oriented CAD/CAM/CAE application developed by KE Fibertec AS. WinVent 3D is always kept up to date with the latest technology and product documentation in TBV. ”

## DESIGN IN WINVENT 3D

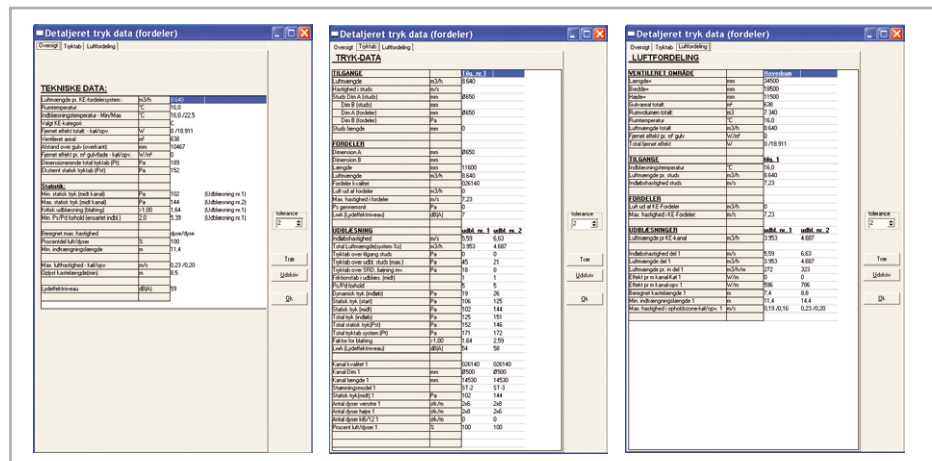
All projects are dimensioned online using our WinVent 3D program, which is always kept up to date with the latest technology and product documentation in textile based ventilation. WinVent 3D is an object-oriented CAD/CAM/CAE application developed by KE Fibertec AS. WinVent is currently used by all KE Fibertec's partners worldwide and all quotations and orders are transferred online via the Internet.



WinVent 3D offers our sales engineers the following features:

- Rapid, easy component assembly in both 2D and 3D
- Online price calculation
- Automatic technical data update
- Complete sound calculations per room
- Production and customer drawings in 2D and 3D, as well as transfer to AutoCAD
- Preparation of electronic order confirmations
- Direct transfer of orders to laser cutters
- and many, many more!

” KE Fibertec puts large emphasis on proving that our textile based ventilation systems will work, which is why we specify all the relevant parameters. We also make sure that the end user's requirements are always met! ”

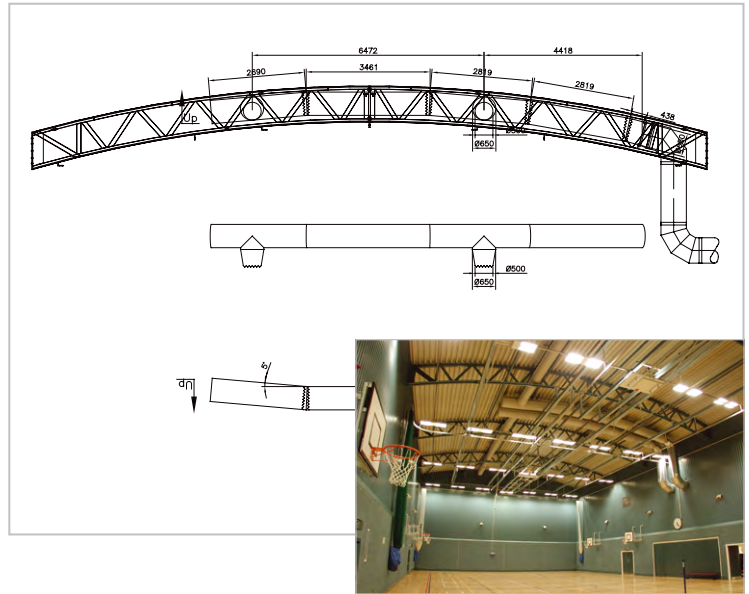


## AUTOCAD DRAWINGS

Depending on the complexity of the project, KE Fibertec produces drawings for quotations and orders. Our drawings can be split into four categories according to their purpose:

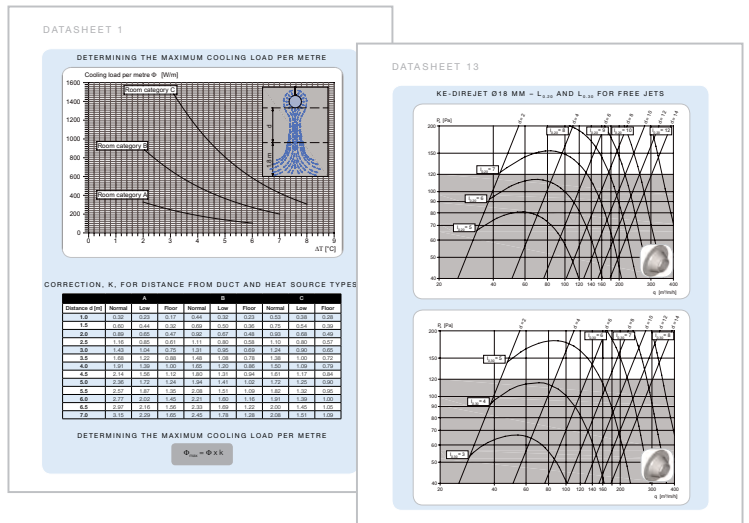
- Sketches
- Sales drawings
- Production drawings
- Installation drawings

If there are existing drawings for a specific project we will use these as the basis for our design and layout.



## PRODUCT DOCUMENTATION

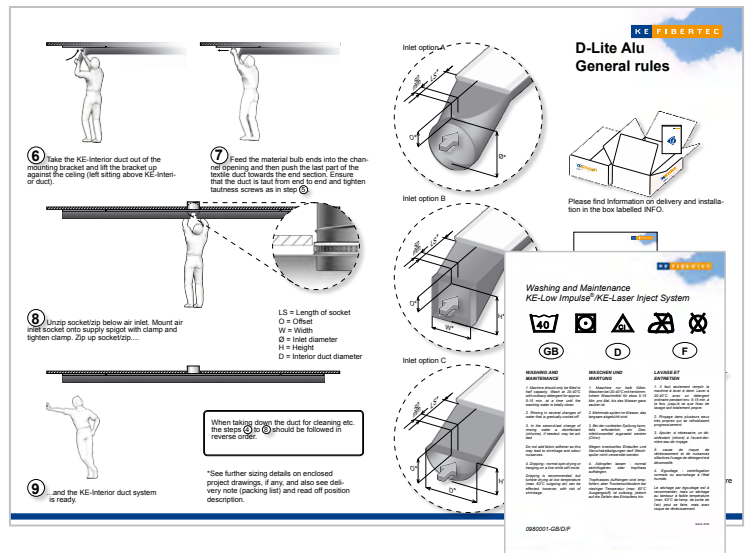
KE Fibertec AS puts large emphasis on being able to document all our products. KE Fibertec wants to be the preferred partner in textile based ventilation, which is why it is important for us to ensure that our documentation always meets your requirements. All our products have been tested and documented in our laboratory and all the data is accurately described in catalogues and in our calculation program WinVent. This offers all our customers the benefit of our expertise.



## PROJECT DOCUMENTATION

All our orders obviously include separate installation instructions, as well as washing and maintenance instructions.

Fire permits and other certificates are included on request.



## EXTENDED PROJECT DOCUMENTATION

KE Fibertec is the only company in textile based ventilation to offer extended project documentation as part of major, complex projects.

Our extended project documentation includes:

- Full-scale testing in our laboratory
- On-site measurements
- CFD simulations

## FULL-SCALE TESTING IN OUR LABORATORY

Full-scale measurements can provide a very attractive solution in more complex projects. If the end user has any doubt about how the system will work and look or if there are very specific room-related reservations, they can contact KE Fibertec and our sales staff will submit, in conjunction with the development department, a proposal as to how a particular problem can be resolved in the best way. Our full-scale laboratory is fully equipped so that we can visualise different solutions with smoke or we can choose to set up a full-scale model of the relevant premises to illustrate and document the air distribution and indoor climate. We also offer on-site measurements taken at the end-user's premises, if this is required. We are able to offer the following:

- Pressure measurements in ducts
- Measurement and logging of air temperature
- Measurement and logging of air humidity
- Measurement of duct speeds using a thermal antenna anemometer
- Measurement of air velocities in rooms using a hot-sphere anemometer
- Volume flow measurements
- Visualisation with smoke

” KE Fibertec's development department is always available to provide full-scale measurements which can illustrate air flows and indoor climate parameters for a specific project. ”



## ON-SITE MEASUREMENTS

As part of KE Fibertec's quotation, you can request assistance with measuring your own premises and advice about the choice of ventilation solution and layout. When the textile based ventilation system has been installed we can also give advice on how to set the system's parameters. If any unexpected problems arise or you are simply interested in having the indoor climate documented, our development department can also offer to take measurements on site. This also helps us to provide a better service!

## CFD SIMULATIONS

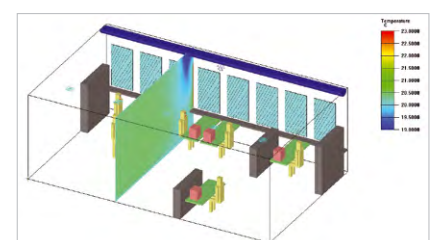
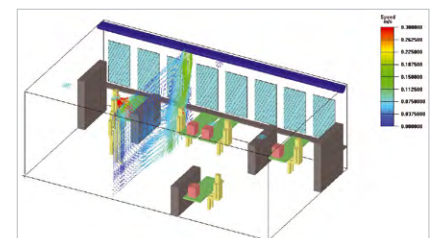
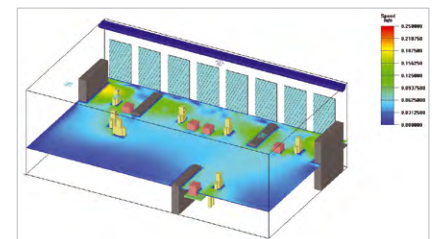
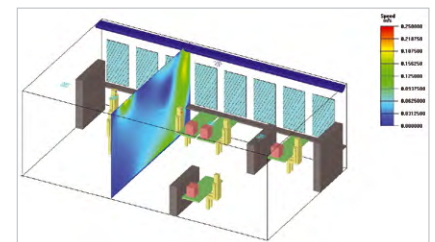
KE Fibertec can provide CFD simulations as a major supplement to both technical air calculations in WinVent 3D and full-scale measurements. CFD stands for Computational Fluid Dynamics and is a method of computer simulation used for air flows and temperature and concentration distribution.

CFD simulations enable us to create a computer-based model of premises with textile based ventilation and to simulate, optimise and evaluate the indoor climate or a specific process.

CFD simulations make a practical, but also time and resource-consuming tool. CFD simulations require a vast amount of computer power, depending on the complexity and size of the task, to come up with a correct, reliable solution within a reasonable timescale. A great deal of expertise in how things function and operate in textile based ventilation is also required. CFD is a very effective tool for determining flow-related phenomena, but it is important to bear in mind that CFD cannot replace full-scale measurements and laboratory tests. And also remember:

**“CFD simulations cannot replace general common sense and more than 30 years' experience in air distribution.”**

CFD simulations give KE Fibertec the opportunity to carry out a risk assessment and offer better advice about air distribution in your project, even at the design stage. This enables us to ensure that the systems function the way they are supposed to, thereby preventing problems with penetration lengths in heating installations being too short or with the supply air being short circuited. The key thing for a CFD simulation is to document more accurately the air distribution and indoor climate.



## FACTS ABOUT CFD SIMULATIONS

A CFD simulation is performed by numerically solving the differential equations governing the air flow, known as the Navier Stokes equations. As CFD simulations often include complicated three-dimensional flows with heat transfer, heat radiation and turbulence, the governing equations can only be solved in a very few cases.

To solve the flow's differential equations they must be rewritten as algebraic differential equations. This is done by splitting the CFD model into a large number of control volumes (calculation grid), after which each of the governing equations is solved numerically for each calculation cell. This will provide a complete picture of the pressure, velocity and temperature distributions.



## 6. LOW IMPULSE SYSTEMS



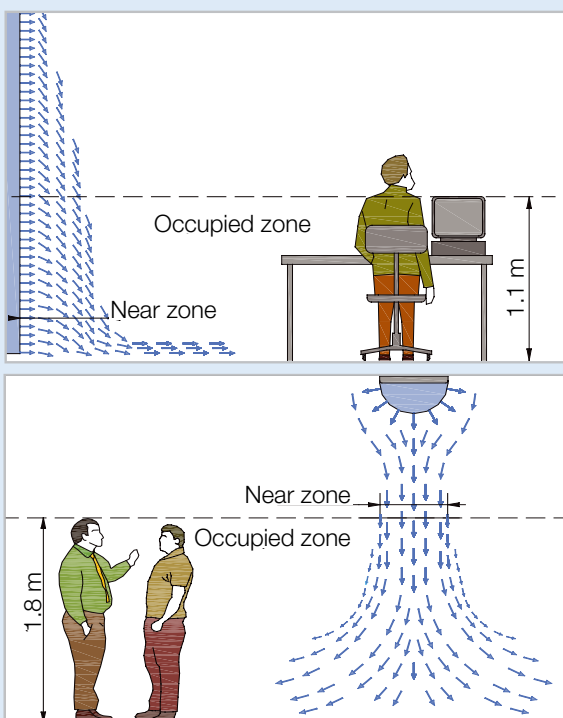
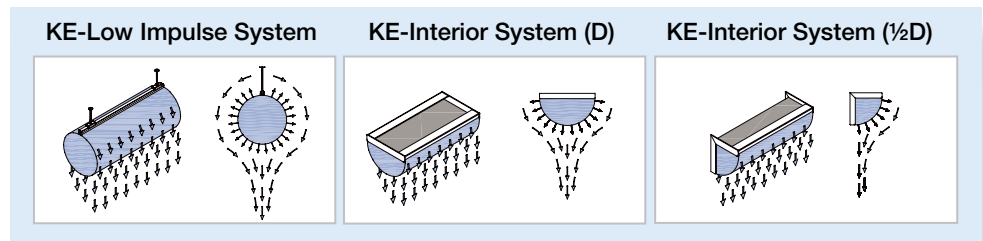
## TEXTILE BASED VENTILATION SYSTEMS

The air distribution principle used for a textile based ventilation system is fundamentally different from a conventional ventilation system equipped with steel ducting and conventional air distribution fittings. Most architects, consultants and fitters in the ventilation industry are already familiar with the general principles of TBV systems, but not all of them are familiar with the latest product versions and design options. The following three chapters provide a brief description of KE Fibertec's product versions, along with a description of the air distribution principles for all product types.

## TEXTILE BASED LOW IMPULSE SYSTEMS

KE Fibertec markets two products for textile based low impulse ventilation: the KE-Low Impulse System and KE-Interior System. The KE-Low Impulse System is produced using round ducts ( $\varnothing$ ), while the KE-Interior System is produced using half-round (D) or quarter-round ( $\frac{1}{2}D$ ) ducts. There is basically no difference in the air distribution principle when using these product versions. For this reason, just one description of the air distribution principle will be given below for the systems.

## PRODUCT RANGE: LOW IMPULSE SYSTEMS



## OCCUPIED ZONE FOR LOW IMPULSE SYSTEMS

The occupied zone is the area in a room which people occupy for a long period of time and is defined as the area where efforts are made to maintain the indoor climate at a general level.

The occupied zone is not a standardised area, but a zone which is defined from one project to another in consultation with the architect and client. The occupied zone is often defined as the zone from the floor up to a height of 1.8 m above people who are in a standing position doing their job, while this height is set to 1.1 m for people who are seated.

## NEAR ZONE FOR LOW IMPULSE SYSTEMS

In the case of horizontal low impulse systems, the near zone is defined as the zone under the textile ducting where there is the biggest risk of a "cold downdraught" or of draughts in general. The width of the near zone can be reckoned to be no more than three times the duct diameter.

In the case of vertical low impulse systems, the near zone is defined as the local zone around the duct where the air velocity is too high in relation to the room's comfort requirements (depending on the room category).

## HORIZONTAL LOW IMPULSE SYSTEMS

The air distribution principle for horizontal low impulse systems is based on passive thermal displacement where the air is supplied at a lower temperature in relation to the air in the room. Because of the difference in density, with the cooled air being heavier than the warmer air in the room, the room air is displaced below the duct while the supply air continues moving towards the floor. The air flow in the room is then based on natural air movements where the air is driven by the difference in density and convection flows from heat-releasing activities and processes, hence the term "passive thermal displacement". A high level of heat activity from heat sources generates bigger convection currents, resulting in the air rising more strongly and greater entrainment of the air around the source. This results in stratification in the ventilated room where heat and pollution are drawn away from the occupied zone and extracted under the ceiling.

A low impulse system can **only** be used for cooling purposes or for distributing large volumes of isothermal air, as warm air will settle under the ceiling like a blanket. When this occurs, the supply air is short circuited, which means a waste of energy.

KE Fibertec's textile based low impulse systems are woven from Trevira CS polyester yarn, and the textile surface acts as a fine mesh, allowing the supply air to pass through the surface at a very low, uniform discharge velocity, which is normally less than 0.1 m/s. If the air needs to be distributed according to the low impulse principle the discharge velocity should be maintained below roughly 0.40-0.50 m/s. This is the limit at which the room air will start to be entrained and mixed with the low impulse flow.

The picture below illustrates the air distribution principle for horizontal low impulse systems.

” The textile surface of textile based low impulse systems is a fine mesh, which allows supply air to pass through the surface at a very low, uniform velocity. ”



### ZONE 1

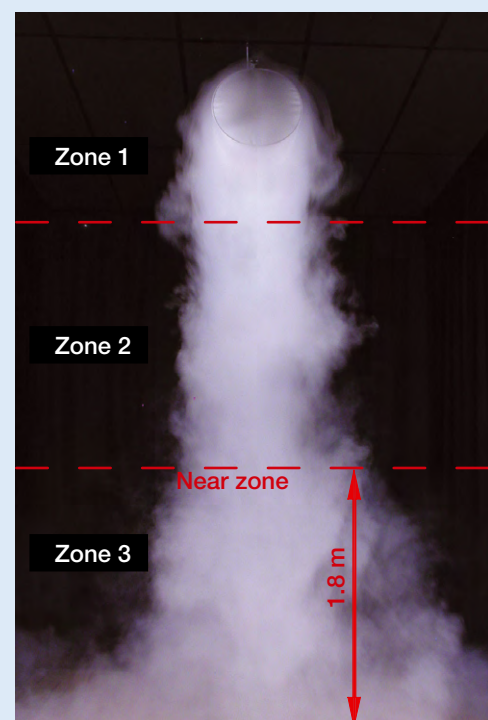
The airflow in zone 1 is particularly reliant upon the cooling load per running metre of duct (W/m). A large cooling load leads to a more powerful acceleration of the supply air into zone 1, which results in the air dropping down and mixing with the rest of the air.

### ZONE 2

In zone 2 the warmer room air is displaced by the cooled air from the low impulse duct. In low impulse flows there is almost no entrainment of the surrounding room air, which can reduce the velocity level before the flow reaches the occupied zone. This means that a higher starting level will result in a higher end velocity when the air enters the occupied zone.

### ZONE 3

The width of the near zone is also particularly reliant upon the cooling load per running metre of ducting. The larger the cooling load, the narrower the near zone. The width at the entrance to the occupied zone can be reckoned to be no more than three times the diameter of the low impulse duct.



As has just been mentioned on the previous page, the cooling load per running meter of ducting is crucial to how the air flow will be under the ducting, but the location of the heat sources in the room also has a major influence on the air flow. The following parameters are crucial for air velocity and air temperature under the duct:

### Cooling load per running metre of ducting

Large cooling demands result in higher discharge velocities and a greater temperature difference between the room air and the supply air ( $\Delta T$ ). Both these parameters end up accelerating the supply air's velocity.

### Location of heat sources

Measurements have shown that equally distributed floor heat accelerates the discharge velocity much more than heat sources located high up in the premises (1.5 to 2 m above floor level).

Unlike the cooling load per running metre of ducting, the static pressure, which keeps the textile duct inflated, does not have any particular influence on the air flow's distribution in the room. No matter how great the static pressure is in the duct, there is not sufficient force (momentum) in the jet to give the air a throw length which is typical of KE Fibertec's high impulse systems.

” The static pressure, which keeps the textile duct inflated, does not have sufficient momentum to give the air a throw length which is typical of KE Fibertec's high impulse systems. Due to the difference in density between the supply air and the room air, the supply air is displaced towards the floor immediately after passing through the textile surface. ”

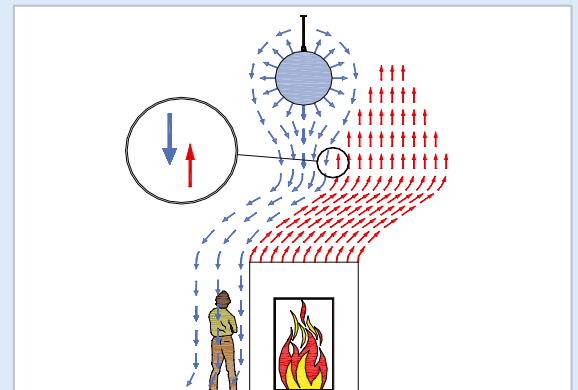
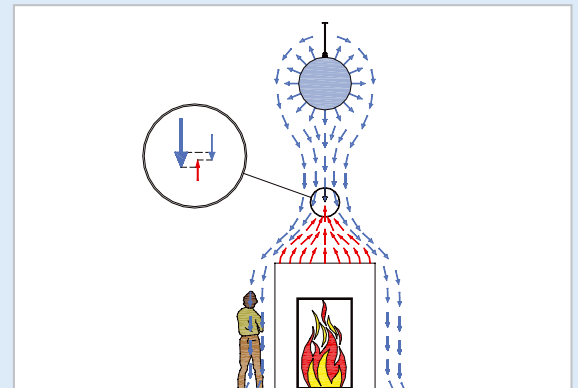


As mentioned above, it is important to clarify how the heat load is distributed in the premises as it makes a big difference whether the heat loads come from machines, people or lighting, or whether it mainly takes the form of transmission heat from surrounding premises. As low impulse flows are only controlled by thermal forces, the location of heat sources and heat-releasing processes in the room is a vitally important parameter when calculating low impulse flows. KE Fibertec's room classification (as also shown in datasheet 1) takes into account the heat distribution which normally occurs in different types of premises. You are recommended to use these dimensioning values. The room classification and information in datasheet 1 give clear guidelines on how large the cooling load can be with different comfort level requirements.

## LOCATION OF HEAT SOURCES

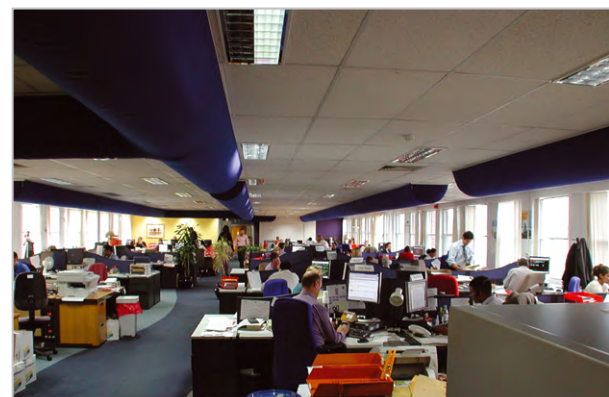
At heat sources convection heat rises up and will, at a certain propagation angle, meet the downcoming air from the ducting. This phenomenon is also encountered with large window panels where the convection heat from radiators located under the windows counteracts the cold downdraught. If the heat sources are located at a height the resulting air velocity will be somewhat lower when the current arrives down in the occupied zone. In other words, if the downcoming air velocity is greater than that of the upcoming warm air, the current will continue downwards, but at a reduced velocity.

In theory, you can calculate the convection velocities above almost every common heat source. If you also know the air velocity under the low impulse duct you can, in principle, calculate the resulting air velocity, but this procedure is definitely not to be recommended! In reality, you will come across countless instances where the cold current can “spread out” to the side and veer away from the duct’s centreline and continue at a greater velocity than expected, with the subsequent risk of draught problems.

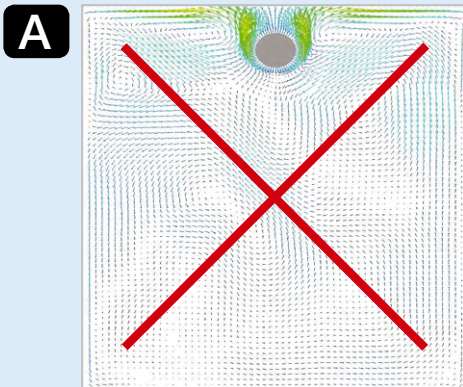


If the premises mainly has large concentrated heat sources it is important for low impulse ducts to be placed lower in the room and distributed between the heat sources rather than above in order to achieve a good displacement effect and prevent unnecessary mixing with the polluted air from the upper zone and buoyancy from machines. This will help to flush the work zones under the textile ducting very effectively. It is extremely important that the number of textile ducts and their location precisely match that of the machines and that the ducting runs for the whole length of the heat source. If the heat sources are distributed more evenly, like in office premises for instance, the low impulse ducts should be placed in corridor areas or along walls to avoid a drop of cold air at fixed workplaces. If the upcoming convection heat blocks the low impulse current, undesirable stratification can occur, with cold air on top and hot air underneath. To avoid a sudden drop of cold air, known as a “turbulence draught”, it is important to create a balanced system so that the risk of a drop of cold air does not arise.

The location of the exhaust grilles also affects the air distribution in the premises. Return flow towards an exhaust grille positioned at floor level can feel like a draught, especially in cold production facilities where even very low air velocities feel uncomfortable. The usual recommendation is for extraction vents to be positioned at ceiling level, spread a certain distance apart. Large doors or windows which are opened regularly also have an impact on air distribution as the uneven pressure conditions can cause an inflow of air from outside and from surrounding premises.

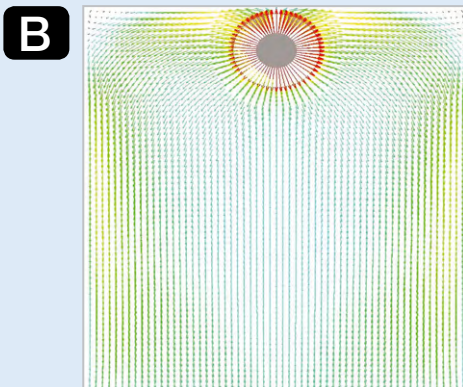


The figures below illustrate the typical flow pattern under a horizontal KE-Low Impulse System in a heating scenario, ventilation scenario and two cooling scenarios with a different cooling load per running meter of ducting.



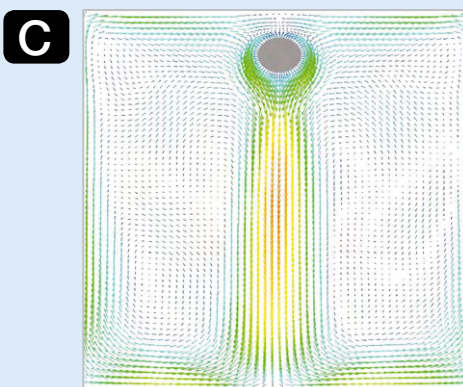
$$\Delta T < 0^{\circ} \text{C}$$

A delivery of heated air results in the supply air being short circuited where the air forms a blanket under the ceiling. Low impulse systems are therefore not suitable for heating.



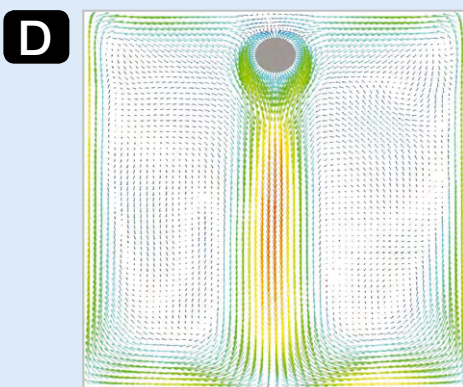
$$\Delta T = 0^{\circ} \text{C}$$

A delivery of isothermal air produces a very diffuse flow pattern. Downward air movements (in the direction of the occupied zone) are often required, in which case the recommendation can be made to increase the discharge velocity to 0.40-0.50 m/s, which is the limit if the air is going to be supplied according to the low impulse principle. At discharge velocities above 0.50 m/s you can expect the surrounding room air to start being entrained.



$$\Delta T < 3^{\circ} \text{C}$$

A delivery of supercooled air produces the typical downward flow pattern characteristic of low impulse ventilation using textile ducting. A delivery with a moderate cooling load does not, under normal circumstances, cause any discomfort in the near zone, even for those people who are seated. The maximum cooling load obviously depends on the distance from the low impulse ducting to the occupied zone. The maximum cooling loads per running metre of ducting as a function of the room's height can be consulted in datasheet 1.



$$\Delta T > 5^{\circ} \text{C}$$

As the cooling load per metre of ducting increases, the flow pattern under the low impulse duct changes and the near zone becomes narrower, which means that the air velocities and air temperatures vertically under the duct may cause discomfort. A delivery of extremely supercooled air with a cooling load of more than 700 W/m of ducting should mainly only be used where comfort is a minor consideration. However, it is possible to deliver very large volumes of cool air, bearing in mind though that the air distribution will not be 100% perfect.

$\Delta T < 0^\circ\text{C}$



$\Delta T = 0^\circ\text{C}$



$\Delta T < 3^\circ\text{C}$



$\Delta T > 5^\circ\text{C}$



## VERTICAL LOW IMPULSE SYSTEMS

The air distribution principle for vertical low impulse systems is, as with horizontal low impulse systems, also based on passive thermal displacement where the air is supplied at a lower temperature in relation to the room air. The air is supplied, as in conventional displacement ventilation, at floor level, directly in the occupied zone. This creates a stratified flow where the cooled supply air flows out into the room under the warmer room air.

In the same way as with horizontal low impulse systems, the flow in the room is based on natural air movements where the air is driven by a difference in density and by convection flows from heat-releasing activities and processes. Convection flows at heat sources generate a vertical air flow in the room, thereby creating a clean zone on the bottom and a polluted zone on top. A high level of heat activity from heat sources generates bigger convection flows, resulting in the air rising more strongly and greater entrainment of the air around the source.

As the cold supply air only mixes to a small extent, it is important the air is supplied at a low velocity and slight temperature difference as otherwise there is a risk of a cold draught from the ducting, entailing the risk of a draught at floor level. The systems can, like horizontal low impulse systems, only be used for cooling purposes or for distributing isothermal air, as warm air will settle under the ceiling like a blanket.

Vertical low impulse systems are particularly well-suited to premises with high ceilings, excess heat and pollution as warm air and polluted particles are drawn up under the ceiling. As the flow generated in the premises is moving vertically upwards, the heat and pollution do not return to the occupied zone. The picture below illustrates the basic principle of vertical low impulse ventilation.



### ZONE 1

The airflow in zone 1 is particularly reliant upon the cooling load per running metre of duct. A large cooling load results in a greater downward acceleration for the supply air in zone 1.

### ZONE 2

The near zone, which should not be used as a permanent workplace, is defined as the distance from the duct before the velocity is reduced to an acceptable level, depending on the comfort requirement. The length of the near zone is particularly dependent on the cooling load.

### ZONE 3

It is very important that the volume of air from the vertical low impulse system has been adapted to the cooling requirement and that the volume of air supplied is at least equivalent to or greater than the convection flows generated by the heat sources. This helps to achieve the best displacement effect and create a clean zone at the bottom and a polluted zone on top.

The vertical textile ducts supply fresh air directly in the occupied zone, which will obviously result in stratification in the ventilated room. This will cause a temperature gradient through the room, with the coldest air at the bottom and the warmest on top. This can be used beneficially to reduce the cooling load as the cooling load removed from the room is directly proportional to the difference in temperature between the supply air and extracted air. If the air is extracted from the top of the room this will be warmer than the air in the room's occupied zone, allowing the same cooling load to be removed from the room with a higher supply temperature. This results in energy savings when the cooling coil in the air conditioning unit is operating. It also means that free cooling can be used for longer periods of the year.

The required cooling load, combined with any comfort requirements, provides the basis for determining the volume of supply air and the supply temperature. To determine the necessary cooling load accurately, you need to calculate internal and external heat loads, while taking into account the heat accumulation in the building.

In the case of displacement ventilation, comfort requirements also include, apart from air velocity and air temperature requirements, the requirement for the maximum permitted thermal gradient in the occupied zone. KE Fibertec recommends that the maximum thermal gradient in the occupied zone does not exceed 1-2°C/m as any bigger difference may feel like a draught. The vertical thermal gradient can be approximately calculated based on a so-called 50% rule, which states that half of the temperature rise from supply to extraction takes place at floor level, while the other half takes place between the floor and ceiling. Contact KE Fibertec's development department for more information.

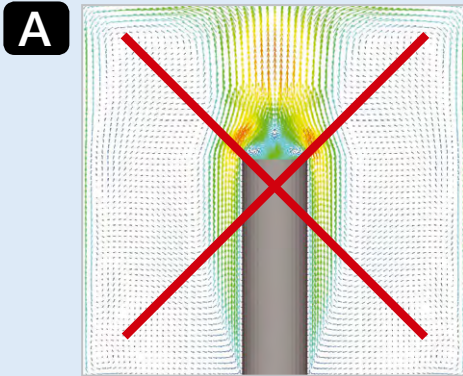
Designing a ventilation system with vertical low impulse ducts requires considerable knowledge about the heat distribution in the premises. It is vitally important that the ventilation system is dimensioned correctly so that it takes into account the level of comfort in the premises' work zones and the heat and polluted air are carried upwards and out of the occupied zone. To displace the polluted air it is important that the volume of air supplied is at least equivalent to the total convection flow volume in the room. If this is not the case, the front of the polluted air will be dragged down towards the occupied zone, thereby reducing the effectiveness. Many factors affect the size of convection flows in the room, such as the shape, area and surface temperature of the heat sources. But factors like the ambient temperature in the premises also have an impact. This is why it is often difficult to determine accurately the convection currents and table values must be used instead.



” Displacement ventilation with textile ducting tends to be used a lot in industrial environments, but can also be used in environments where there are high demands for comfort. ”

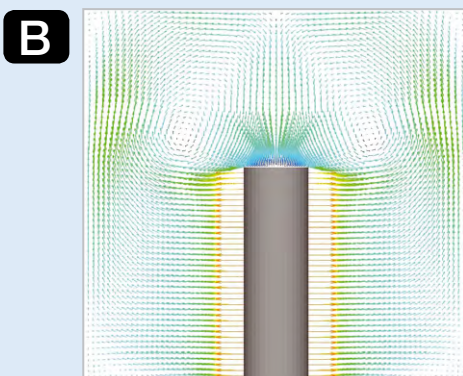


The figures below illustrate the typical flow pattern under a vertical KE-Low Impulse System in a heating scenario, ventilation scenario and two cooling scenarios with a different cooling load per running meter of ducting.



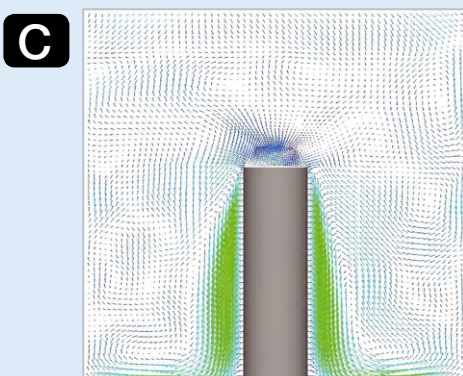
$$\Delta T < 0^\circ\text{C}$$

Delivering heated air short circuits the supply air, which means that the system is not suitable for heating. However, the heated air has a certain penetration, which initiates air circulation in smaller premises. As a result, the system can be used, to a certain extent, to heat the room before work begins or it is used.



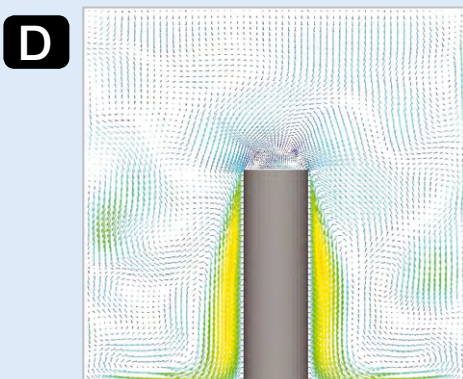
$$\Delta T = 0^\circ\text{C}$$

Delivering isothermal air produces a very diffuse flow pattern, which does not generate a powerful displacement effect. Systems are suitable, to some extent, for supplying replacement air.



$$\Delta T < 3^\circ\text{C}$$

If slightly supercooled air is supplied the air will slowly drop towards the floor and be distributed evenly around the duct. In the event of heat-releasing activities and processes, the convection flows will entrain the supply air, thereby creating stratification in the room where the heat and pollution are drawn away from the occupied zone and extracted under the ceiling.



$$\Delta T > 5^\circ\text{C}$$

If extremely supercooled air is supplied the air will quickly move towards the floor, thereby causing a greater risk of draught problems around the duct as the length and width of the near zone around the duct are increased. In the event of heat-releasing activities and processes, the convection flows will entrain the supply air, thereby creating stratification in the room where the heat and pollution are drawn away from the occupied zone and extracted under the ceiling.

$\Delta T < 0^\circ\text{C}$



$\Delta T = 0^\circ\text{C}$



$\Delta T < 3^\circ\text{C}$

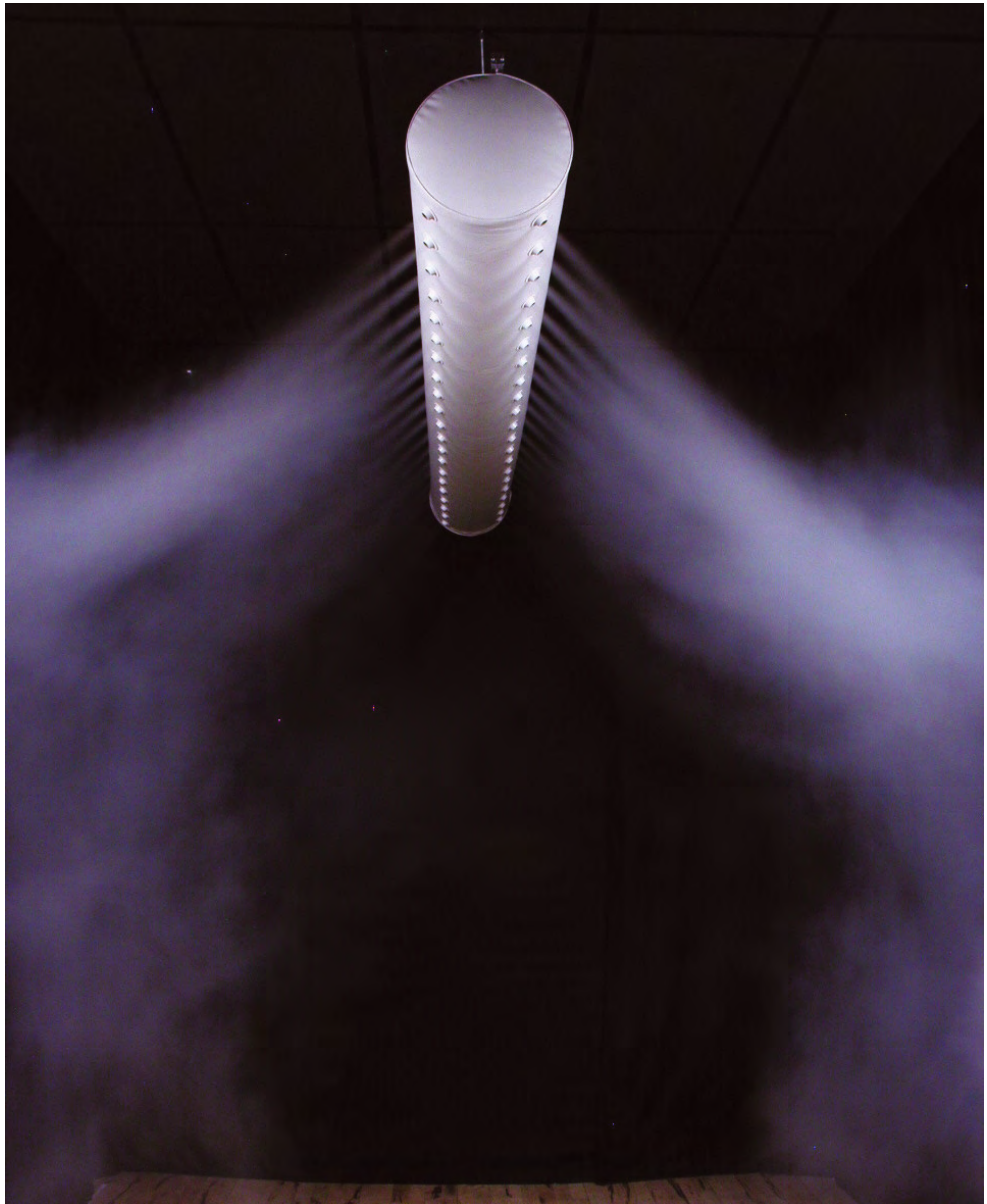


$\Delta T > 5^\circ\text{C}$





## 7. HIGH IMPULSE SYSTEMS

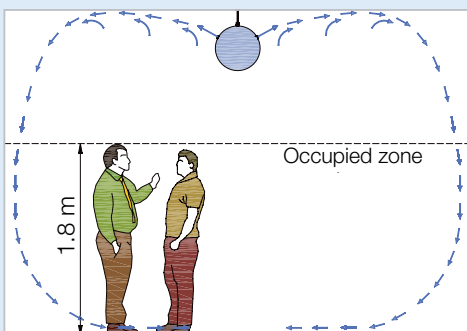
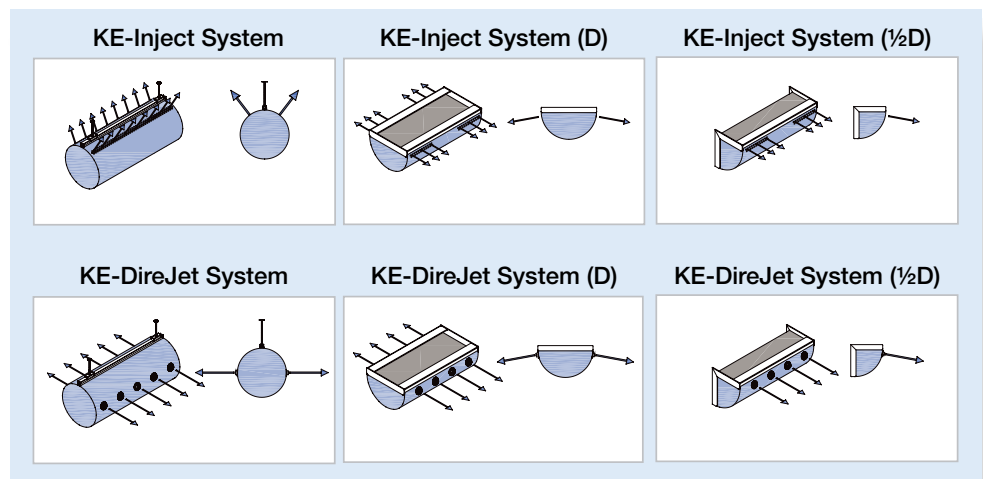


## TEXTILE BASED HIGH IMPULSE SYSTEMS

KE Fibertec markets two products for textile based high impulse ventilation: the KE-Inject System and KE-DireJet System. Both these systems can be produced in the form of round ( $\emptyset$ ), half-round (D) or quarter-round ( $\frac{1}{2}D$ ) ducts. The KE-Inject System comprises groups of small holes in the textile duct, while the KE-DireJet System comprises rows of conical nozzles specifically for directional air distribution.

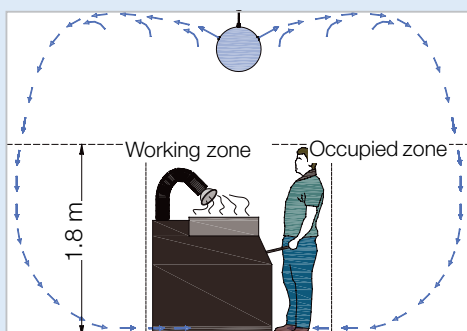
From a ventilation technology perspective, both the KE-Inject System and KE-DireJet System can be regarded as high impulse systems for mixing ventilation. For this reason, one general air distribution principle will be described for these systems, while the specific product features will be described separately.

## PRODUCT RANGE: HIGH IMPULSE SYSTEMS



## OCCUPIED ZONE FOR HIGH IMPULSE SYSTEMS

As with low impulse ventilation, the occupied zone is not a standardised area, but a zone which is defined from one project to another in consultation with the architect and client. The occupied zone is often defined as the zone from the floor up to a height of 1.8 m above people who are in a standing position doing their job, while this height is set to 1.1 m for people who are seated.



## WORKING ZONE FOR HIGH IMPULSE SYSTEMS

In the case of industrial premises, it may also be appropriate for high impulse systems to divide the room up into a working zone as the state of the air may vary from the general level as a result of industrial processes. Heat and pollution sources are often present which require special measures to be able to maintain a satisfactory indoor climate in the working zone. If processes are carried out which cause extreme pollution, textile based ventilation should therefore be supplemented with local extraction vents.

## AIR DISTRIBUTION PRINCIPLE

KE Fibertec's high impulse systems are based on mixing ventilation and are characterised by the fact that air is delivered at a high velocity outside the occupied zone. The high air velocity rate in the air jet will generate excess pressure, resulting in an inflow and entrainment of room air towards the air jet supplied. During the first air flow cycle the air velocity will be high, but as the quantity of room air that becomes mixed increases, the air velocity will decrease. If the system has been dimensioned properly the delivered air volume will be completely mixed with the room air before it reaches the occupied zone and the air velocity rate has dropped to the desired level, depending on the room category. In a mixing ventilated room air velocities, air temperatures and humidity will be distributed identically and in theory, the air quality will be the same everywhere in the room.

A textile based high impulse system, unlike its low impulse counterpart, can be used for cooling, ventilation and heating. The reason for this is that KE Fibertec's high impulses systems, unlike its low impulse systems, are less dependent on external effects, such as convective heat currents in the room. The supply air is delivered with high initial energy in the form of velocity (momentum) through holes or nozzles, with the effect that the air is discharged into the room instead of being distributed through a textile surface at low velocity. This means that KE Fibertec's high impulse systems have what are known in flow engineering as a throw length and penetration length.

Compared with low impulse systems, the location of the exhaust grilles is only of minor significance to the air flows in the room. In practice, they are often positioned along the ceiling. The picture below illustrates the air distribution principle for high impulse ventilation.

### ZONE 1

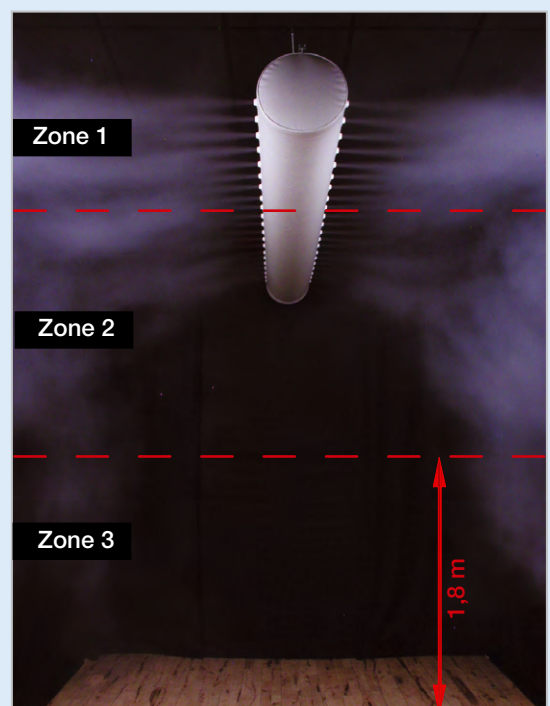
The air is delivered at high velocity, often up to 15-18 m/s, through the holes (KE-Inject System) or nozzles (KE-DireJet System). This generates excess pressure in the centre of the air jets, resulting in an inflow and entrainment of the air in the room towards the air jet supplied.

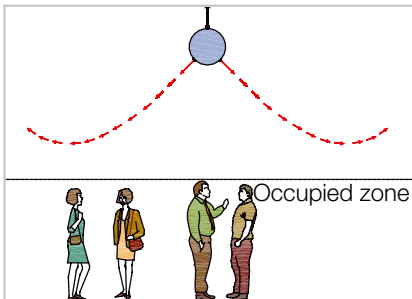
### ZONE 2

As the volume of entrained air increases, the air velocity in the flow gradually decreases. The velocity decreases in inverse proportion to the distance from the duct.

### ZONE 3

In premises where a certain comfort level is required, the air velocity at the entrance to the occupied zone must be adapted to the conditions, which mainly depend on the level of activity of the people working there and what they are wearing (room category). To ensure that a suitable air velocity is achieved, the distance from the duct to the occupied zone must be greater than the calculated throw length (see definition on page 57).





## SHORT CIRCUITING WARNING

It is important to be aware that mixing ventilation also entails a risk of the supply air being short circuited (accumulated under the ceiling). This problem may occur if overheated air is supplied combined with an excessively low discharge velocity, or if there are strong upward currents in the premises, preventing the air from reaching the occupied zone. This problem becomes particularly apparent when the  $\Delta T$  is more than 7-12°C. In the best case scenario, the poor heat distribution in the room can be compensated for by raising the supply temperature, but if the heating coil in the air conditioning unit does not have sufficient capacity to do this, the temperature in the occupied zone will fall. This situation is very inconvenient, both from an energy and comfort perspective.

To make sure that short circuiting is prevented, heated air must only be delivered if the supply temperature and discharge velocity are adjusted. This means that the warmer the supply air, the higher the discharge velocity needs to be to ensure that the air reaches the occupied zone. If the ceiling is particularly high ( $h > 8-10$  m) the ducts need to be dimensioned for a high static pressure to be able to push the air down into the occupied zone. If this is not possible, the ducts can be positioned at a height of 5 metres, for instance.



## FREE JET

If the air jet is directed outwards into the open room, this is what is known in flow engineering as a free jet. The turbulent air jet entrains air from its surroundings and the jet's diameter increases in proportion to the distance from the duct, while the velocity in the jet decreases.



## WALL JET

If the air jet is directed towards a surface, this is what is known in flow engineering as a wall jet. The flow can be regarded as a bisected open jet as the surface can be regarded as a plane of symmetry. The maximum velocity is achieved close to the surface and is  $\sqrt{2}$  greater than the equivalent velocity for an open jet at the same distance from the duct.

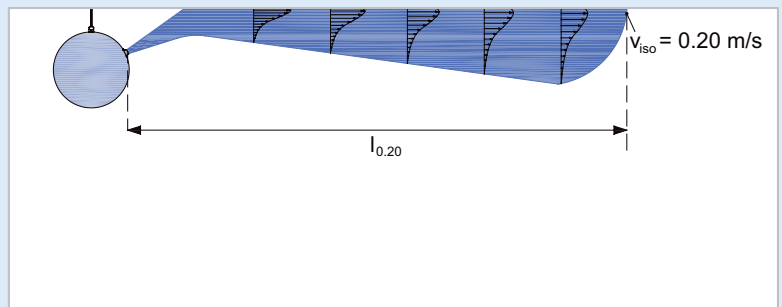
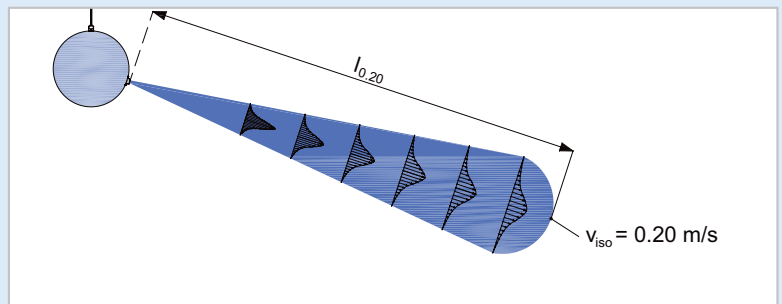
## FREE JETS AND WALL JETS

A crucial factor for the air distribution principle behind the KE-Inject System and KE-DireJet System is the main direction of the air jets. If the jet is directed outwards into the open room, this is what is known in flow engineering as a **free jet** and if the air jet is directed at a surface, this is a **wall jet**. The difference between these two flow phenomena is their ability to entrain room air. If the jet is directed towards the ceiling surface it will try to “stick” to this surface because a negative pressure is generated between the jet and the ceiling as no replacement air can be supplied for the volume of room air entrained by the jet. This is known as the “Coanda effect” and it increases the throw length by a factor of  $\sqrt{2}$  in relation to the throw length for a free jet, while the velocity rate in the jet decreases proportionally more slowly. The air velocity needs to be a minimum of 0.35 m/s to be able to utilise the Coanda effect.

### THROW LENGTH

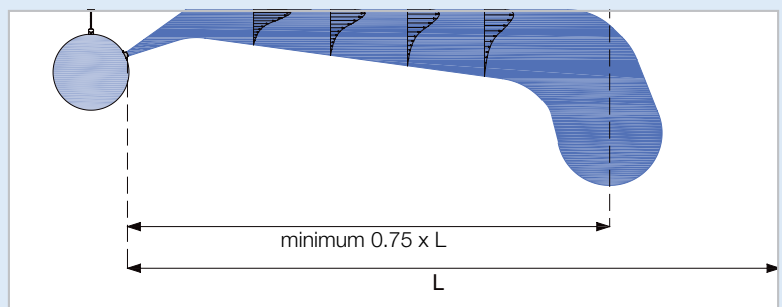
The throw length is defined as the largest distance from the supply duct to a specific point in the premises where the air velocity is precisely equal to the desired final velocity, e.g.  $v_{iso} = 0.20$  m/s. It is important to note that the throw length, by its definition, is valid in isothermal conditions. As a result, the calculations for air velocities must be corrected if the supplied air is either colder or warmer than the surrounding room air.

The throw length for a wall jet is  $\sqrt{2}$  longer than for an equivalent free jet. The reason for this is because a wall jet sticks to the ceiling due to the Coanda effect and as a result, only half the volume of room air contributes to reducing the velocity rate.

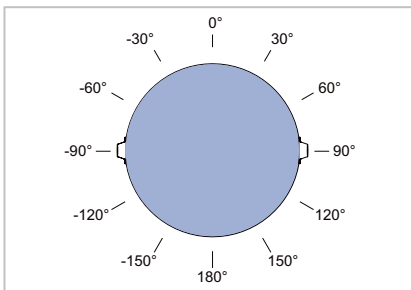


### THERMAL PENETRATION LENGTH

The thermal penetration length is absolutely crucial in determining whether the air is actually distributed as expected. The theory underlying wall jets is actually based on the fact that the jet will not become so “heavy” that it will leave the ceiling’s surface before it is supposed to. If it does, the air velocity at the entrance of the occupied zone will be higher than calculated. This means that it will feel uncomfortable for anyone located in the zone affected by the jet. To prevent any drop of cold air, the thermal penetration length must be checked to see that it is at least 75% of the horizontal distance along the ceiling,  $L$ , where the air is moving.



” All KE Fibertec’s textile based ventilation solutions are 100% customised. Any direction can be chosen for the holes in the KE-Inject System and for the nozzles in the KE-DireJet System. Depending on the system’s usage, the holes/nozzles can be pointed in any direction, specified at an angle from 12 o’clock. ”

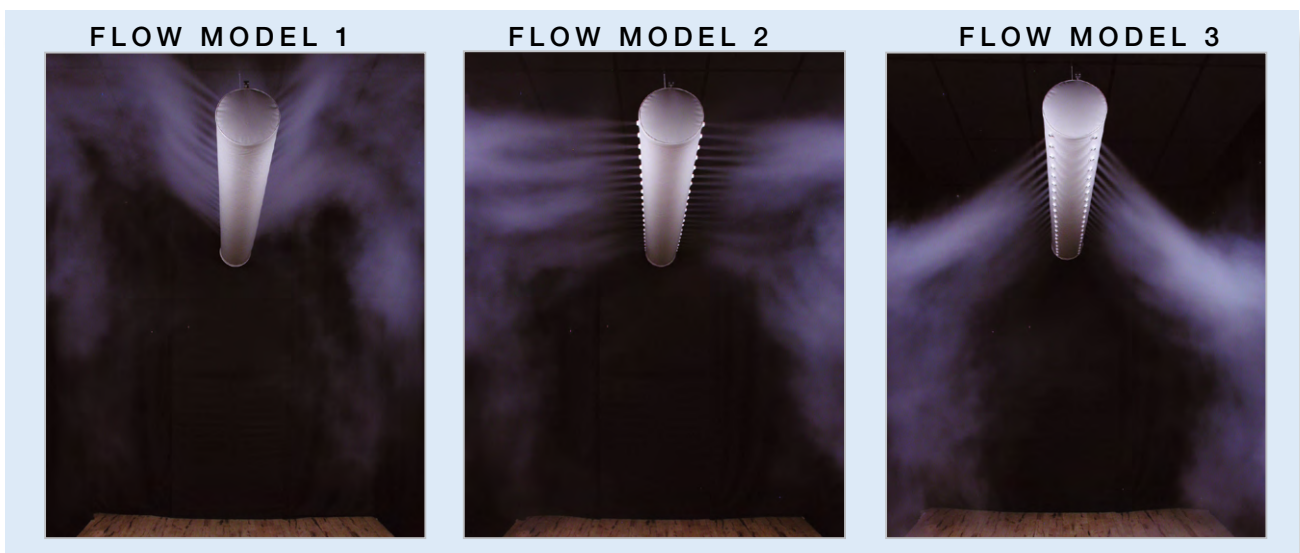


## USING FLOW MODELS

Both the KE-Inject System and KE-DireJet System are highly flexible systems and any direction at all can be chosen for the air jets. It is obviously important for the air jets to point in the main direction of the air flow following the desired air flow pattern in the room. As mentioned earlier, it is also important that the air flow is directed downwards towards the occupied zone when heating is required in order to prevent short circuiting. Apart from choosing the main direction for the air jet, secondary nozzle positions can be used. For instance, if the ceiling needs to be coated locally to avoid the formation of condensation or part of the area needs to be cooled down/heated, it is possible to direct individual nozzles or holes towards the relevant area. Nozzles can also be left out entirely in sections of the duct if no air needs to be supplied.

KE Fibertec uses three different flow models for textile based mixing ventilation in its everyday activities, which are flow models 1, 2 and 3 respectively. To be able to use KE Fibertec’s datasheets properly, you need to know which flow model is involved as all the datasheets have been specified for flow models 2 and 3, i.e. free jets. It is important therefore to clarify what the user wants and needs in terms of the system, as well as to become familiarised with processes and activities before starting to dimension the final design for the high impulse system.

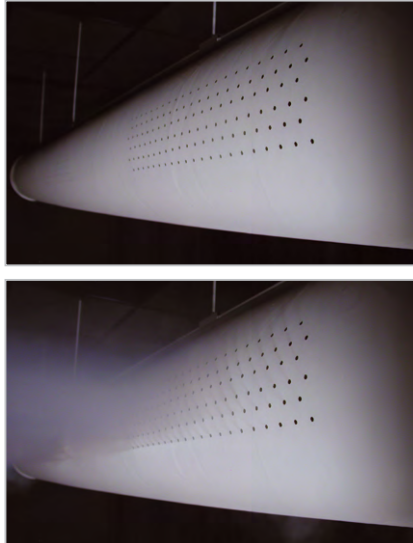
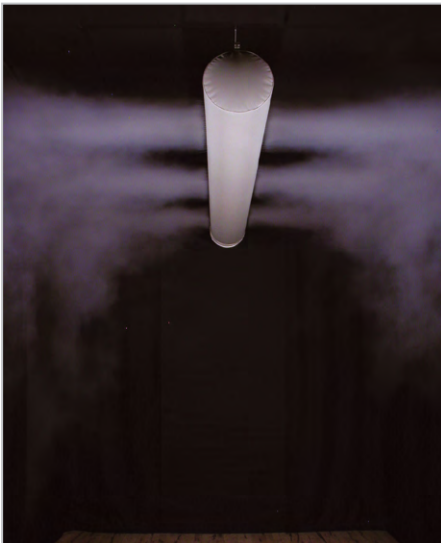
Using flow model 1 (wall jet) can bring some benefit, even though the throw length increases as a result of the Coanda effect. Air jets tend to become more stable when cooled air is delivered, while the risk of a drop of cold air or draughts in general in the occupied zone is kept to a minimum. The Coanda effect also makes the blanket of air “stick” to the ceiling, which means that it will not be deflected by local heat sources, obstacles etc. Consequently, there is a greater likelihood of achieving the desired flow pattern in reality than with delivering an free jet. As was mentioned before, it is recommended to use flow model 2 or 3 for both the KE-DireJet System and KE-Inject System if the system is going to be used to provide heating. This will then eliminate the risk of the supply air being short circuited.



## PRODUCT FEATURES OF KE-INJECT SYSTEMS

The key difference between the KE-Inject System and KE-DireJet System is induction, i.e. the ability to entrain room air. The KE-Inject System comprises groups of small holes in the textile, resulting in an induction of room air on a huge scale around the jet. This means that the velocity rate in the jet is reduced more quickly than for the KE-DireJet System, but the throw length and penetration length are also reduced.

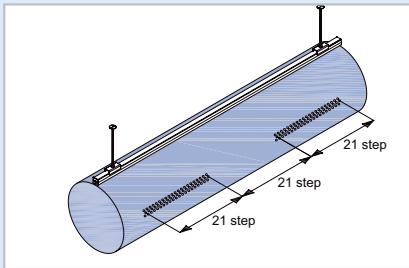
The KE-Inject System offers so much flexibility in production that it is possible to create solutions specifically tailored to the individual function. The model which is suitable for the relevant purpose from among flow models 1, 2 or 3 is chosen according to the system's requirements specifications. Combination solutions including the three flow models can also be used. This may be relevant, for example, if you want to supply heated air, where flow model 2 or 3 is recommended, while also coating the ceiling (flow model 1) to prevent the formation of condensation, which often occurs in food production facilities, for instance.



” The KE-Inject System comprises small holes in coated textile material (airtight). The delivery of air through the holes causes induction of the room air on a large scale, resulting in a relatively rapid reduction in the air velocity rate in the jet compared to the KE-DireJet System. ”

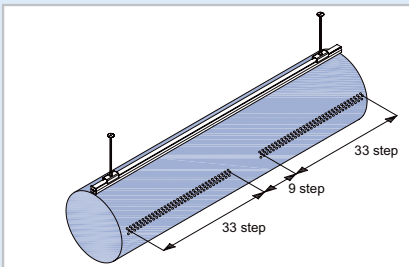
KE Fibertec markets three types of KE-Inject Systems, with their characteristic patented hole design running along the duct's longitudinal surface. As can be seen on the next page, the number of holes per metre is constant, regardless of the length of the duct. The only option for adapting the number of holes to the relevant volume of air is by having more or fewer rows of holes on the duct's circumference. Consequently, KE Fibertec indicates the number rows of holes in a dimensioning context. This should then be understood as the total number of hole rows placed on the duct's circumference, with the holes grouped in a particular design along the duct's longitudinal surface.

KE Fibertec has well-documented measurements of throw lengths etc. for these three Inject-type systems. It is therefore recommended to adhere to the hole design as much as possible. If this cannot be adhered to the system should then be dimensioned in cooperation with KE Fibertec's development department.



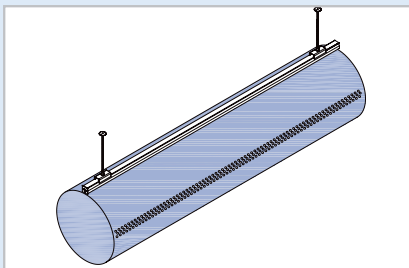
## KE-INJECT LOW VELOCITY (LV)

The hole design for the KE-Inject Low Velocity System comprises 21 holes per row, followed by 21 steps without holes. One characteristic feature of KE-Inject Low Velocity is that it helps achieve a particularly good mixing capability. The high level of induction of air around the duct results in a reduction of the throw length, which means that large volume flows can be delivered, along with a large cooling load per m<sup>2</sup> of the floor area. See datasheets 7 and 8 for further information.



## KE-INJECT MEDIUM VELOCITY (MV)

The hole design for the KE-Inject Medium Velocity System comprises 33 holes per row, followed by 9 steps without holes. A good mixing capability is also typical of this system, but it is better suited for supplying warm air, compared to KE-Inject Low Velocity. See datasheets 7 and 9 for further information.



## KE-INJECT JET (JET)

The hole design for KE-Inject JET comprises 42 holes per row. There are no steps between the sections of holes. A typical feature of the KE-Inject JET System is that mixing/induction of room air is limited, resulting in a very large throw length (up to 15 metres). The system also has a large penetration length, making it ideal for ventilating large areas. These features also make this system well-suited for supplying warm air. See datasheets 7 and 10 for further information.

The special hole design produces an extremely good injection effect, i.e. the air jets operate like a row of small missiles. The high velocity rate generates a relatively large amount of low pressure behind the jets, which is crucial to the inflow of room air from zones around the KE-Inject duct. The injection effect can be improved further if the air jets are directed towards the ceiling because the inflow of room air is reinforced as the heat naturally rises upwards in the premises. Another benefit from grouping the holes in a particular design is the opportunity it provides to control the flow. The air jets from the many holes will see their angle of propagation continually increase as room air is entrained and mixed. After a short time the air jets will converge and continue like a single blanket of air.

If the holes are grouped with a large distance between them a larger volume of room air needs to be mixed before the air jets converge and form an air blanket than if the holes are placed in a hole design with a small distance between them. As the drop in velocity in the jet mainly depends on how much room air is mixed in, it is obvious that KE Fibertec can control the flow very precisely by changing the hole design. If the requirements are for short throw lengths and a large mixing capability, a KE-Inject Low Velocity System is used, with a large distance between holes in the groups of holes. Similarly, the KE-Inject JET System is used with a small distance between the holes if the blanket of air has a larger stretch to overcome. In these situations the KE-DireJet System is also ideal.



## PRODUCT FEATURES OF KE-DIREJET SYSTEMS

As mentioned in the previous section, the key difference between the KE-Inject System and KE-DireJet System is their ability to entrain room air. The KE-DireJet System is made of a coated or permeable textile material with rows of conical nozzles for 100% active, directional delivery. The conical nozzles limit the induction of room air around the individual air jet, whereby the velocity in the jet decreases relatively slowly compared to the KE-Inject System. As a result of this, both the throw length and thermal penetration length are extended considerably for the KE-DireJet System.

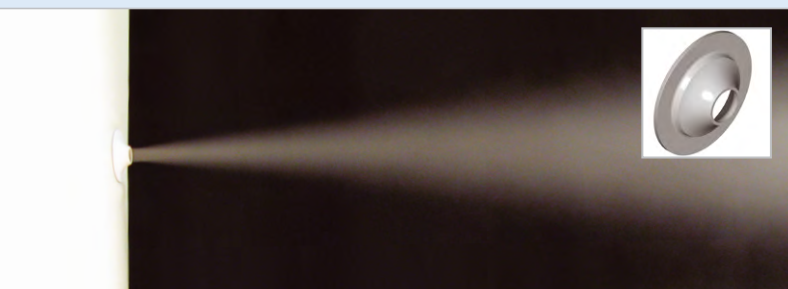
” The KE-DireJet System is often used in large premises with large throw lengths. The choice of nozzle depends on the system’s performance, the relevant room and the indoor climate requirements. ”

KE Fibertec is the only distributor of textile ducts that offers five different nozzle sizes: Ø12, Ø18, Ø24, Ø48 and Ø60 mm. The flexibility in the choice of nozzle size offers great benefits as the KE-DireJet System can be used in virtually every type of premises that requires mixing ventilation, even in extremely large premises, such as high-bay warehouses or large sports arenas. The nozzle size and flow model naturally depend on the requirements specification for the ventilation system, and KE Fibertec will obviously advise on the best choice of nozzle size and direction. Ducts are often used with different nozzle types and flow models in the same duct. This allows you to achieve the flow pattern and air intensity in the various zones exactly how you want.

The conical nozzles are fitted in holes made of coated polyester fabric and are secured using a locking ring. The maximum number of nozzles per row per metre is 14 for the Ø12, Ø18 and Ø24 mm nozzles. If this is not sufficient, it is recommended using two or more rows of nozzles. In the case of Ø48 mm and Ø60 mm nozzles, it is recommended using a maximum of six nozzles per metre. As the number of nozzles per metre is increased, the individual jets will have an impact on each other and they will change character from circular jets to 2-dimensional jets. The velocity rate in the flow will also slow down as the induction of room air is limited the closer the nozzles are placed together. These factors are naturally included in KE Fibertec’s datasheets.

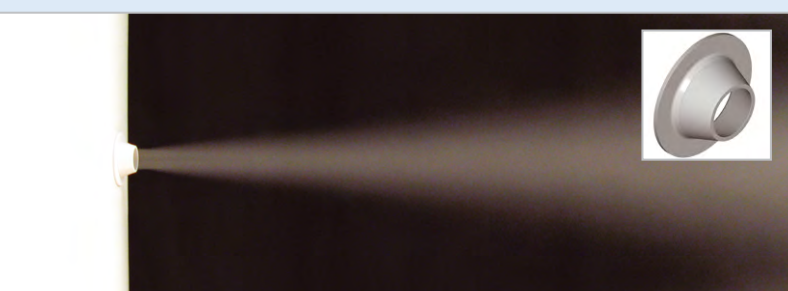
The nozzles can be supplied with nozzle plugs to block the air flow temporarily in certain zones. This is used most often in cases where the system’s features need to be changed for a period of time, for instance, if the premises’ use changes.





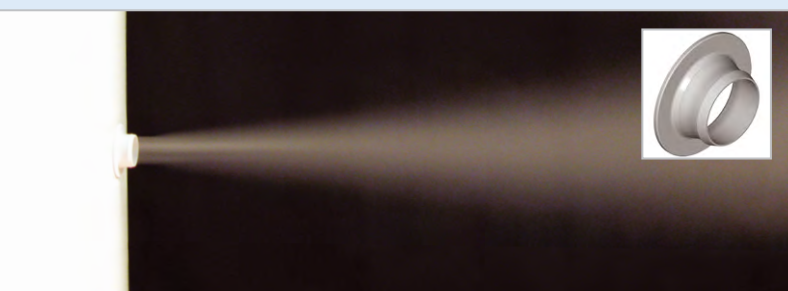
## Ø12 MM NOZZLE

The Ø12 mm nozzle is used where directional delivery is required in a room and comfort requirements are important. Each nozzle delivers 5 m<sup>3</sup>/h with a static pressure of 120 Pa. See datasheets 11 and 12 for further information.



## Ø18 MM NOZZLE

The Ø18 mm nozzle is used where directional delivery is required and often in process-orientated solutions, in a room where relatively large throw lengths are required. Each nozzle delivers 11 m<sup>3</sup>/h with a static pressure of 120 Pa. See datasheets 11 and 13 for further information.



## Ø24 MM NOZZLE

The Ø24 mm nozzle is used for directional delivery in a room with large throw lengths. Each nozzle delivers 20 m<sup>3</sup>/h with a static pressure of 120 Pa. See datasheets 11 and 14 for further information.



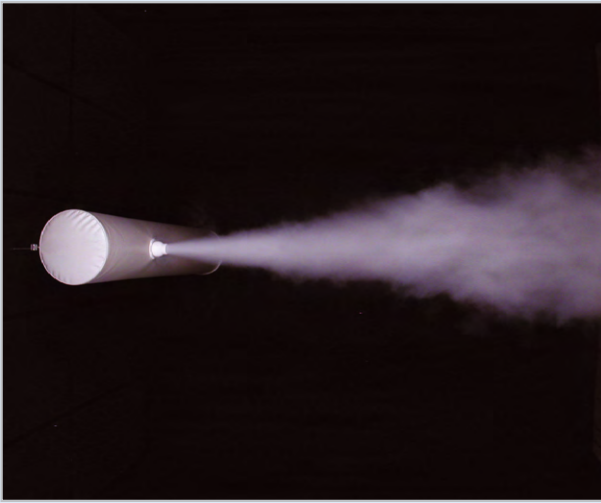
## Ø48 MM NOZZLE (DIREJET VARIO)

The Ø48 mm nozzle is used for directional delivery in a room with very large throw lengths. The flexible nozzle can be turned 30° in any direction around the nozzle's centreline. Each nozzle delivers 81 m<sup>3</sup>/h with a static pressure of 120 Pa. See datasheets 15 and 16 for further information.



## Ø60 MM NOZZLE

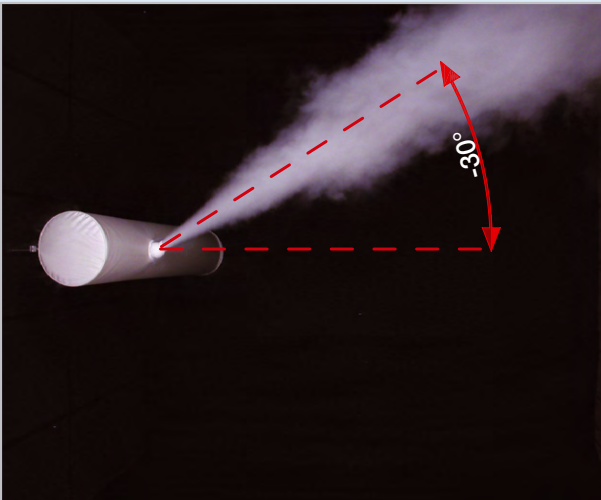
The Ø60 mm nozzle is made up of the bottom of the Ø48 mm nozzle and is used for directional delivery in rooms with very large throw lengths. Each nozzle delivers 139 m<sup>3</sup>/h with a static pressure of 120 Pa. See datasheets 15 and 17 for further information.



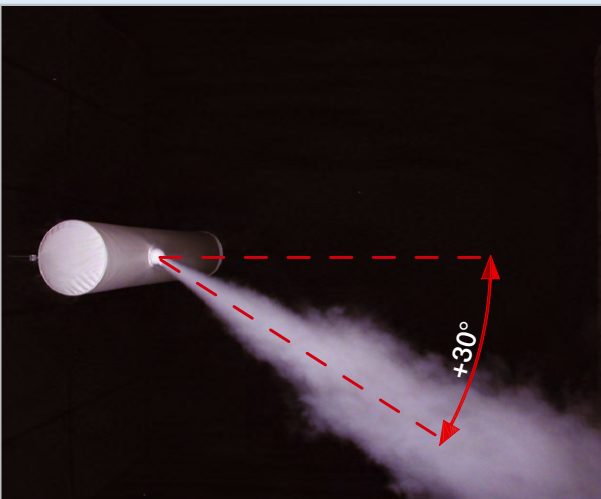
## KE-DIREJET VARIO - THE FLEXIBLE SOLUTION

The latest development of the KE-DireJet System is called KE-DireJet Vario. It is a multi-adjustable nozzle that allows the direction of the air jet to be freely adjusted up to 30° in any direction in relation to the nozzle's centreline.

When dimensioning a system, KE Fibertec takes as its starting point the room's layout and function so that the nozzles are basically placed in the correct position (nozzle adjustment 0°).



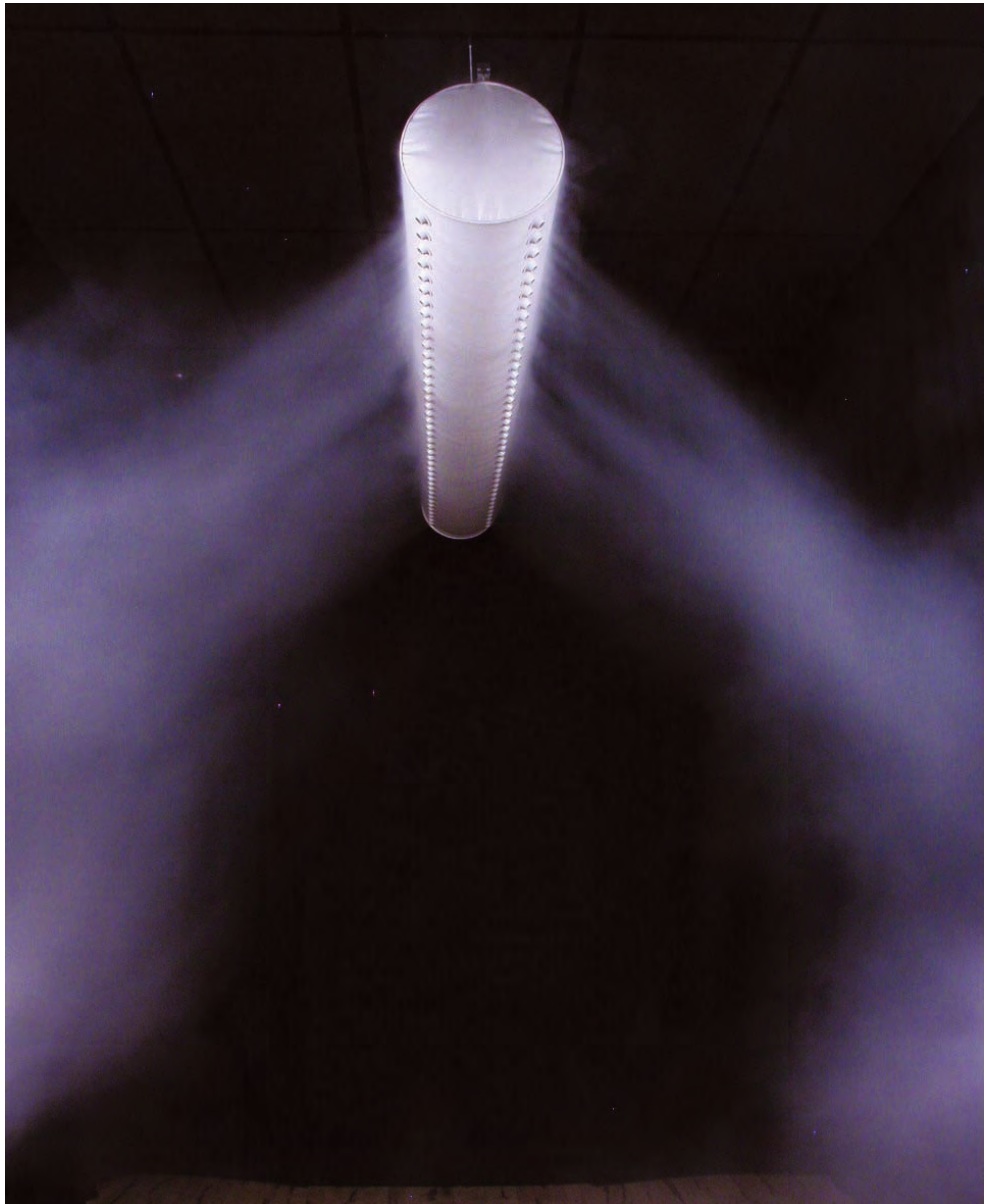
The KE-DireJet Vario nozzle can be adjusted manually so that the main direction of the air jets can be changed by up to -30° in relation to the nozzle's centre line. This may be particularly appropriate if the room's layout is changed after installing the system. This nozzle adjustment can also be used in situations where a large cooling load needs to be supplied in the room.



The manual adjustment can also change the main direction of the air jets by up to +30° in relation to the nozzle's centre line. As mentioned above, this may be particularly appropriate if the room's layout is changed after installing the system. This nozzle can provide great benefit if it is used in situations where a large heating load needs to be supplied for the room.



## 8. HYBRID HIGH IMPULSE SYSTEMS

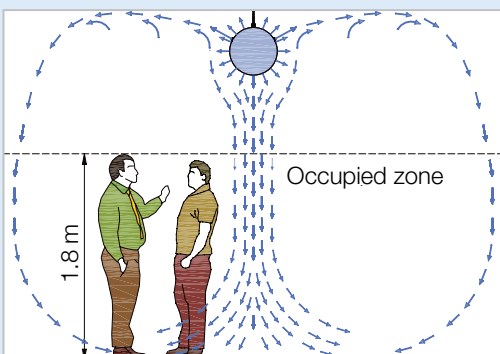
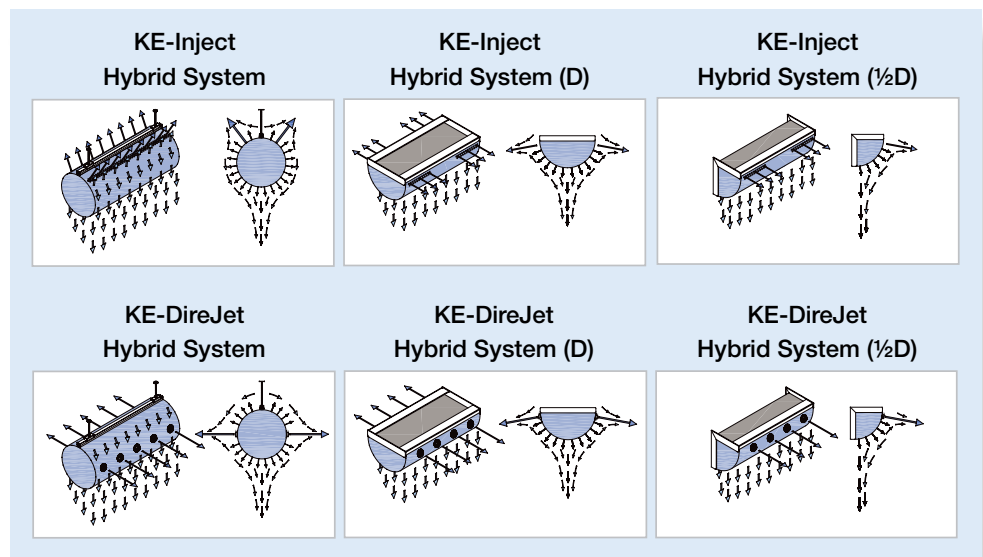


## HYBRID HIGH IMPULSE SYSTEMS

It was previously mentioned that both the KE-DireJet System and KE-Inject System can be regarded as active mixing systems, but this is not necessarily their only function. KE Fibertec AS uses laser technology to facilitate production of more advanced product versions, where passive low impulse ducts can be made more active by laser cutting a number of small holes or inserting nozzles in the textile material. The more holes or nozzles the system has, the more active the textile ducts will obviously become. This will change how the system works from a passive low impulse system to an active mixing system or what is known as a hybrid textile duct.

KE Fibertec markets two products for textile based hybrid ventilation: the KE-Inject Hybrid System and KE-DireJet Hybrid System. These systems are also produced in the form of round ( $\emptyset$ ), half-round (D) or quarter-round ( $\frac{1}{2}D$ ) ducts. From a ventilation technology perspective, the KE-Inject Hybrid System and KE-DireJet Hybrid System can be regarded as a combination of active high impulse ventilation and passive low impulse ventilation.

## PRODUCT RANGE: HYBRID HIGH IMPULSE SYSTEMS



## OCCUPIED ZONE FOR HYBRID SYSTEMS

As with low impulse ventilation, the occupied zone is not a standardised area, but a zone which is defined from one project to another in consultation with the architect and client. The occupied zone is often defined as the zone from the floor up to a height of 1.8 m above people who are in a standing position doing their job, while this height is set to 1.1 m for people who are seated.

## AIR DISTRIBUTION PRINCIPLE

In a nutshell, hybrid systems comprise low impulse ducts which are made active by using holes or nozzles. As a result, the low impulse principle is combined with the high impulse principle, whereby part of the air volume in the system is distributed away from the near zone under the ducts. This offers in particular obvious benefits if cooling is required where  $\Delta T$  is higher than 5-6°C, as it helps avoid an immediate “cold drop” under the ducts. The cooling load is distributed instead across a larger area in the room. Hybrid product versions therefore require air velocities etc. to be calculated for both the low impulse and the high impulse section. It must also be ensured, of course, that the air flow from each of these systems does not contribute to any discomfort in the room.

Manufacturing hybrid high impulse systems opens up a new world of flexibility, but it is also of paramount importance that you are aware of the requirement specifications for the ventilation system. Just a few rows of holes or nozzles can change the flow from a passive low impulse system to an active mixing system. But the major benefits of this new technology are that you can, in theory, actually dimension one and the same system to be passive in some zones and more or less active in others.

Hybrid systems are absolutely ideal for ensuring that optimum air distribution is achieved in systems with both cooling and heating requirements, as a textile duct with holes or nozzles gives the air energy in the form of movement, as has already been mentioned. This means that air currents are not only reliant upon thermals, as is the case with a low impulse system. On the other hand, the air which passes through the textile will not make any significant contribution to air distribution in a system for heating. But the air which passes through the textile material does not disappear and short circuit under the ceiling. The majority of it will instead be entrained by the air jets which pass through the holes or nozzles.

### ZONE 1

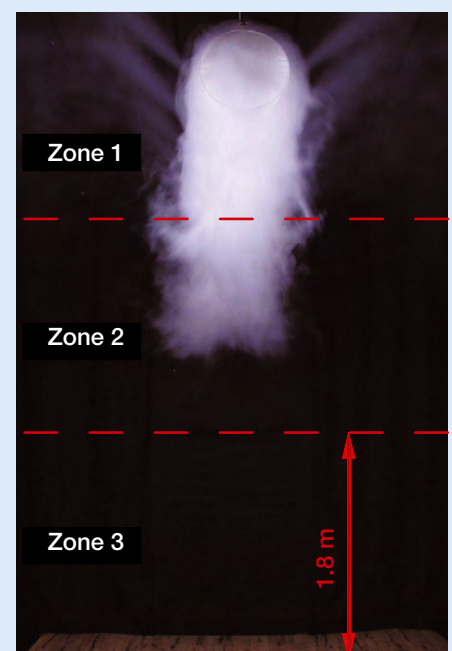
The air is delivered partially at high velocity through the holes or nozzles and at low velocity through the textile material. The excess pressure in the centre of the air jets generates an inflow and causes entrainment of room air, as well as part of the duct's own air. The air's acceleration under the duct (low impulse flow) is particularly reliant upon the cooling load per running metre of ducting.

### ZONE 2

The warmer room air is displaced by the cooled air from the duct under the hybrid duct. Part of the low impulse flow is entrained into the high impulse flow. The velocity gradually decreases in the high impulse flow. The velocity decreases in inverse proportion to the distance from the duct.

### ZONE 3

When entering the occupied zone, it is important to ensure that both the air velocity in the low impulse flow and the air velocity in the jet originating from the holes or nozzles have been adapted to the conditions so that the room's comfort requirements are met.

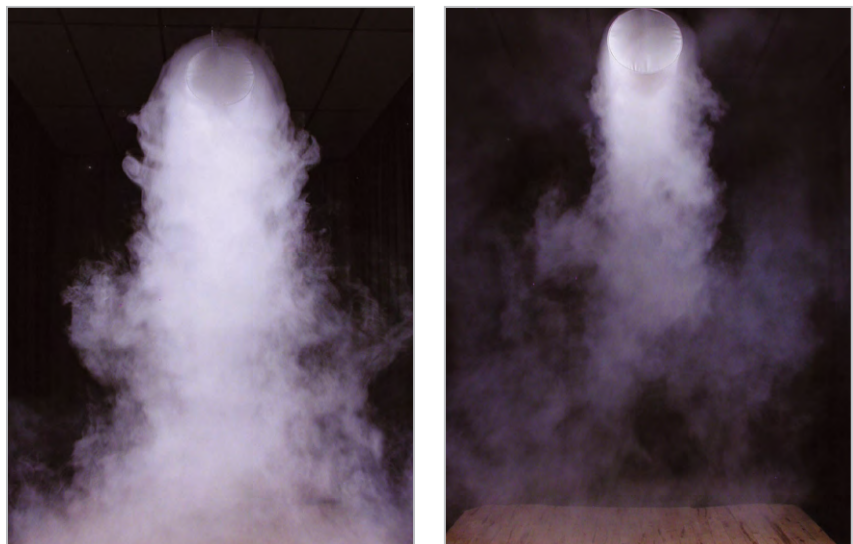


## HYBRID SOLUTIONS FOR ENHANCED COMFORT

The job of hybrid textile ducts, as was explained on the previous page, is to shift part of the air volume away from the area under the duct. If you compare this to a low impulse system, a greater cooling load per running metre can therefore be added without generating a draught under the duct.

The pictures below show a smoke test where a comparison is carried out between a low impulse system and a KE-Inject System with 20% of the air passing through the holes. Both systems are supplied with the same volume of air at a  $\Delta T$  of 5°C. It can be clearly seen from the density of the smoke in the near zone under the textile duct what a large difference there is in air velocity under the duct. It is obviously important to remember that the throw length for the air passing through the holes must be sufficient to prevent draught problems in the occupied zone.

”Smoke test comparing a KE-Low Impulse System and a KE-Inject Hybrid System. It can be clearly seen from the density of the smoke in the near zone under the textile duct what a large difference there is in air velocity under the duct. It is obviously important to remember that the throw length for the air passing through the holes must be sufficient to prevent draught problems in the area where the high impulse flow penetrates the occupied zone.”



Changing the number of holes/nozzles in the textile material helps to combine high impulse systems with the low impulse principle, which means that basically three different types of flow patterns can be obtained. Even a distribution between the textile material and nozzles/holes of 60/40 completely alters the way in which the system operates, from a passive thermal low impulse system to an active mixing system. Even if the distribution between the textile material and holes/nozzles is changed to 0/100, this does not make the flow pattern look noticeably different.

Type of duct	Air through holes/nozzles	Flow pattern	Purpose
Low impulse duct	0%	The air drops down right under the textile duct in cooling mode	Passive thermal displacement/low impulse
Hybrid System	5-10% upwards	The air drops down directly under the textile duct	Coating of ceiling due to condensation problems
Hybrid System	15-30% upwards/side	Part of the air volume drops. Spread 2-3 m	Spread of near zone when cooling > 5-6°C
Hybrid System	> 40%	The air spreads in the main direction of the holes	Active high impulse system

As can be seen from the table on the opposite page, the number of holes or nozzles per metre of ducting has a major impact on whether the delivery will be diffuse or come from a particular direction. KE Fibertec therefore splits the hybrid systems according to three main principles: model A, model B and model C.

#### **MODEL A (5-10% THROUGH HOLES/NOZZLES)**

When model A is used, the delivery is very diffuse, similar to low impulse currents. Model A is used especially in premises with high comfort requirements, i.e. room category A+B. The high impulse principle can be beneficially combined with the diffuse flow pattern from low impulse systems if, for instance, there are periods when there is need for heating or the need for more directional ventilation above a particular machine or process. Furthermore, condensation problems on the ceiling in humid premises can also be rectified by simply placing a very small number of hole rows or nozzles, pointing towards the surface of the ceiling.



#### **MODEL B (15-30% THROUGH HOLES/NOZZLES)**

When model B is used a combination delivery is largely obtained between holes/nozzles and textile materials. Part of the volume flow will in a cooling scenario always drop below the duct, but most of the air is distributed according to the main direction of the holes or nozzles. The combination solution is typically used in premises where there are requirements for both cooling and heating, but with fairly high requirements for comfort in the room, i.e. category B+C.



#### **MODEL C (>40% THROUGH HOLES/NOZZLES)**

Model C is used for highly directional delivery, which is often used with process-oriented solutions or in large premises, such as sports centres. The air will only be distributed in the main direction of the holes or nozzles, which is the case with KE Fibertec's conventional high impulse systems. Directional air distribution through the holes/nozzles is incredibly effective and the flexible positioning of the hole rows and nozzles can, in a sense, meet every function in larger rooms.





## 9. DESIGN CONSULTANCY



**DIMENSIONING  
TBV SYSTEMS**

To be able to dimension a textile based ventilation system, it is important to understand a number of essential parameters and concepts. A textile based ventilation system is not fundamentally different from conventional ventilation systems, but there are a number of key points where it is important to be extra cautious. A brief description is given below of the key parameters and concepts used when dimensioning KE Fibertec's textile based ventilation systems.



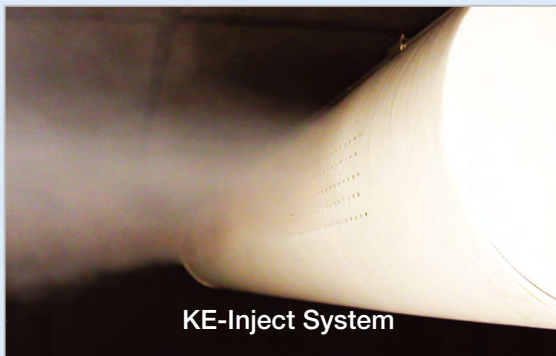
**DELIVERY AREAS**

The entire surface of the KE-Low Impulse System is permeable, which means that the total delivery area corresponds to the geometric surface area. The geometric surface area, A, is given in [m<sup>2</sup>].

**KE-Low Impulse System:  $A = \text{diameter} \cdot \pi \cdot \text{duct length}$**

**KE-Interior System (D)  $A = (1/2) \cdot \text{diameter} \cdot \pi \cdot \text{duct length}$**

**KE-Interior System (1/2D)  $A = (1/4) \cdot \text{diameter} \cdot \pi \cdot \text{duct length}$**



In the case of the KE-Inject System and KE-Inject Hybrid System, KE Fibertec has, for the sake of manufacturability, grouped the holes in different standard patterns, depending on which type is selected, see Chapter 7. A standard pattern is made up of an exact number of hole steps and the delivery area can only be modified by changing the number of hole rows. Consequently, the unit, number of hole rows, is used as a parameter for the delivery area of the KE-Inject System. In the case of the KE-Inject Hybrid System, the whole of the duct's surface, including the holes, will act as the delivery area.



In the case of the KE-DireJet System and KE-DireJet Hybrid System, the delivery area depends on whether a Ø12 mm, Ø18 mm, Ø24 mm, Ø48 or Ø60 mm nozzle is selected, as well as how many nozzles are used per running meter of ducting. With the KE-DireJet Hybrid System, the whole of the duct's surface, including the nozzles, will act as the delivery area.

## PRESSURE CONDITIONS IN TEXTILE DUCTS

As in any other air distribution system, pressure losses also occur in textile based ventilation systems. Calculating the pressure losses in a textile based ventilation system is not basically any different from the generally known practice. The flow in a duct system is only dependent, to a limited extent, on whether the material is made of steel or fabric. However, what is important to be clear about is that textile material is very flexible and it is only kept inflated by the static pressure in the system. As a result, even small turbulences can cause pulsations. This is why it is very important to perform pressure loss calculations to ensure that the textile based ventilation system is operating as it is supposed to without any pulsations, as well as ensuring the best possible energy economy.

### DEFINITIONS OF PRESSURE

The types of pressure that occur in a textile based ventilation system are shown in the figure on the right. The total pressure ( $P_t$ ) can be calculated anywhere in a textile based ventilation system as the sum of the static and dynamic pressures. The following expression applies:

$$P_t = P_s + P_d$$

Where:

- $P_t$  Total pressure in the duct [Pa]
- $P_s$  Static pressure in the duct [Pa]
- $P_d$  Dynamic pressure in the duct [Pa]

#### Total pressure

The total pressure is the pressure that needs to be produced by the fan to overcome the total resistance in the textile based ventilation system, i.e. the loss from the individual types of resistance, such as elbows, frictional loss and the static pressure in the system.

#### Static pressure

The static pressure, which is measured in relation to atmospheric pressure, has an identical impact in every direction and keeps the textile material inflated, as well as pushing the air out through the holes/nozzles.

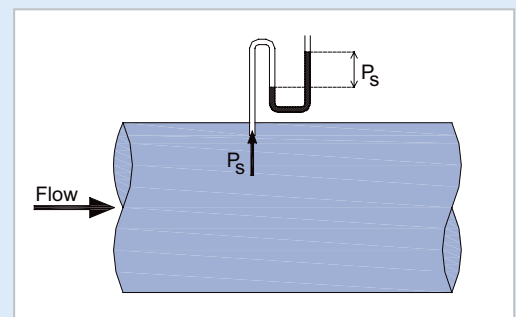
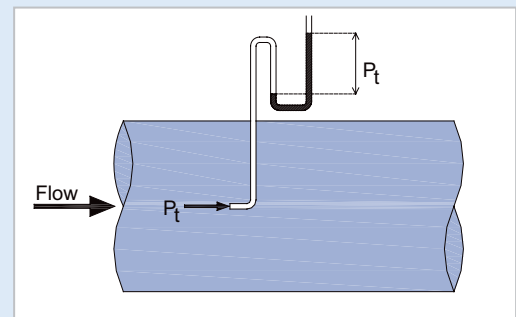
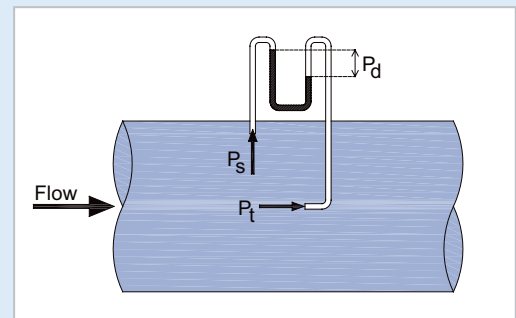
#### Dynamic pressure

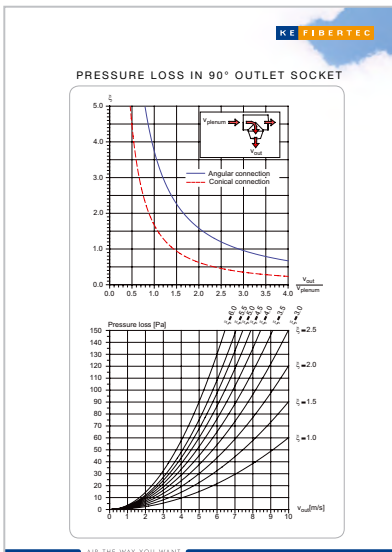
The dynamic pressure, or velocity pressure, has an impact on the direction of the air and carries it from A to B. The dynamic pressure is related to the mean air velocity in the duct and is calculated using the following expression:

$$P_d = \frac{1}{2} \cdot \rho \cdot v^2$$

Where:

- $\rho$  Density of the air [ $\text{kg}/\text{m}^3$ ]
- $v$  Mean air velocity in the duct cross section [m/s]





## PRESSURE LOSS IN TEXTILE DUCTS

The pressure loss which occurs in a textile based ventilation system originates from the following sources:

- Across cross section modifications
- Across branches
- Across elbows
- Friction
- Across flow components (SRD's)
- Across holes, nozzles and textile material ("fittings loss")

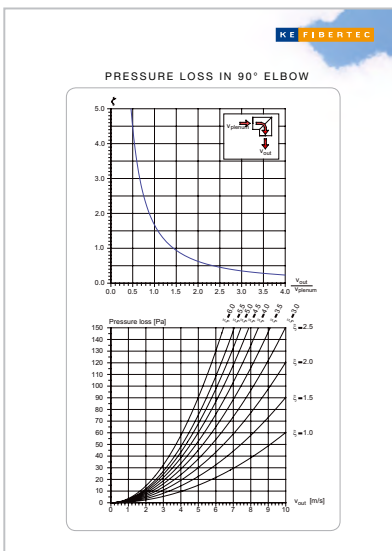
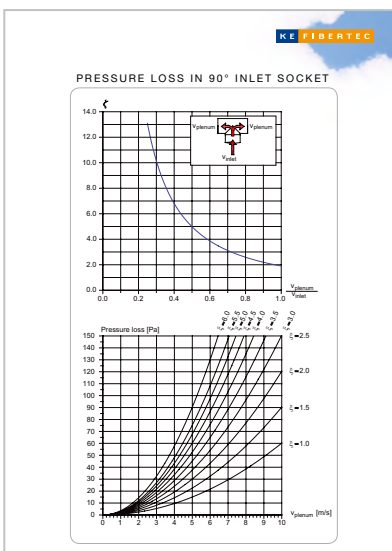
The pressure loss across these various components is a loss that is related to the velocity, and thus is proportional to the dynamic pressure,  $P_{d1}$ , and dependent on what is known as the pressure loss coefficient, which is found when measurements are taken in KE Fibertec's full-scale laboratory. The pressure loss across a component ( $\Delta P_e$ ) is determined using:

$$\Delta P_e = \xi \cdot P_{d2}$$

Where:

$\xi$  Pressure loss coefficient [-]

$P_{d2}$  Dynamic pressure after the component [Pa]



It is very obvious when a textile based ventilation system has been dimensioned incorrectly because the ducts will be oval and "sagging" when you look at them. The difference in the static pressure between two parallel ducts may be quite considerable too. This not only has an impact on the aesthetic appearance, but to a great extent also on air distribution. If the pressure distribution is uneven this can cause draught problems below and around the duct with the highest static pressure, while in the opposite case, the air quality will be poor in the area where the static pressure (and therefore the volume of air) is not sufficient.

KE Fibertec AS has documented pressure loss measurements for all the components featuring in our TBV systems. Contact KE Fibertec's development department for further information.

## PULSATIONS IN TEXTILE DUCTS

Pulsations in textile ducts can most often be attributed to one or more of the following causes:

- 1 If a system has an turbulent air flow in front of the textile duct's inlet this can create a turbulence field in the duct causing pulsations in the textile material. One of the reasons for the turbulent air flow may be changes of direction in front of the textile duct. It is therefore recommended to have a length at least three times the actual diameter in front of the textile duct where the flow profile has been restored. In addition to this, if the air velocity is too high in elbows and attachments, this can also pose the risk of pulsations in the textile material. The risk arises because low pressure may be generated locally in the textile based ventilation system due to return flow. This is often observed inside an elbow where the low pressure will create a wave motion in the textile's surface.

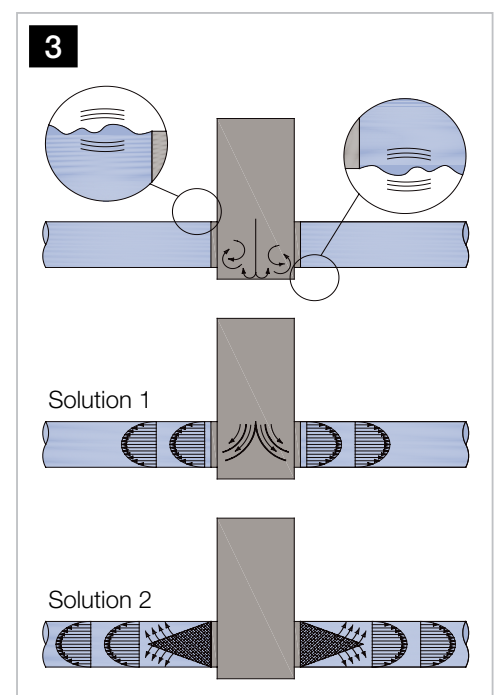
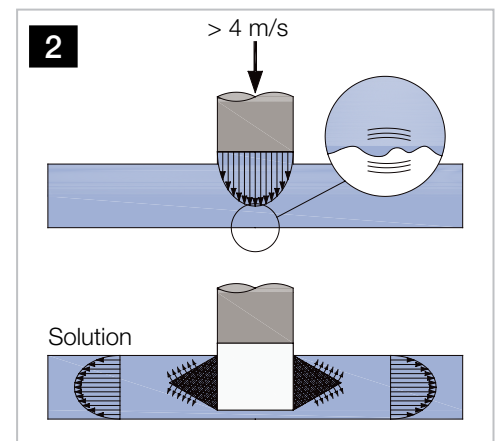
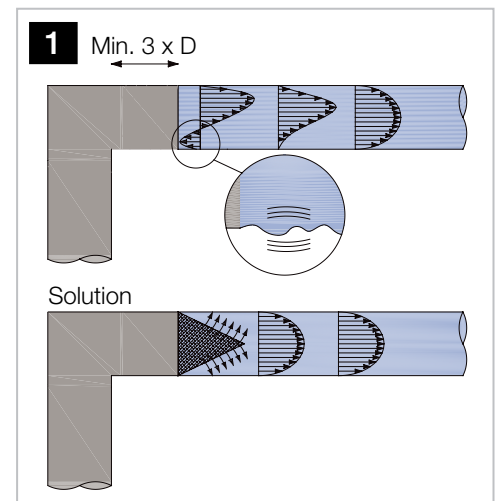
In cross sections with turbulent air flow it may be beneficial to use a KE-SRD (Static Regain Diffuser), which regenerates the flow profile. This is done by forcing the air through a conical mesh so that the air flows perpendicularly on the side of the duct. This then converts the dynamic pressure wave in the duct to a static pressure, thereby preventing pulsations in the relevant cross section. This will obviously cause an additional pressure loss in the system as the static pressure in front of the SRD is raised. The fan must also overcome this pressure loss.

- 2 Textile ducts where the air is delivered from the side or from above, such as D-shaped ducts with an inlet in the roof, are at risk from pulsations. These types of systems are obviously designed with a low inlet velocity, but if the ventilation system's parameters are not set properly this can easily generate pulsating movements at the inlet. The problem can be resolved by using a KE-SRD.

- 3 Textile ducts which are fitted onto sockets at the end of a rectangular steel duct, for instance, are at significant risk of pulsations as the supply air will become very turbulent when it hits the bottom of the steel duct. In these cases, pulsations can be avoided by fitting baffle plates in the steel duct (Solution 1), inserting a KE-SRD (Solution 2) or by extending the steel socket to at least  $3 \times D$ .

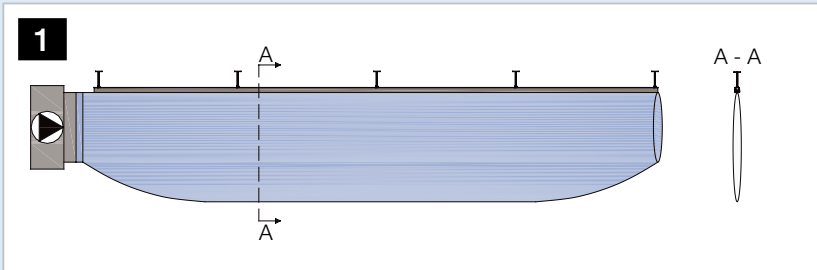
A defective design also creates the risk of pulsations in the textile material. A defective design is often associated with the static pressure in the textile based system not being sufficiently large to compensate for the pressure loss in the sockets and elbows, with excessively high inlet velocities, an asymmetrical system layout or the wrong textile permeability.

To prevent pulsations, KE Fibertec recommends using a pulsation factor to ensure that there is sufficient static pressure available in the system. According to the pulsation factor, the static pressure in the outlet ducts must be greater than or equal to the sum of the dynamic pressure in the outlet duct and the total system pressure loss in the textile based ventilation system.

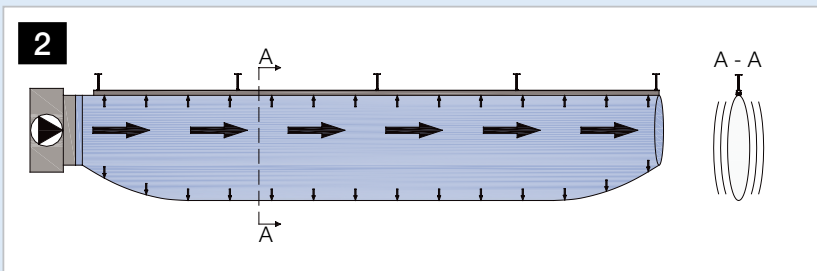


**PRESSURE IMPACT ON SYSTEM START-UP**

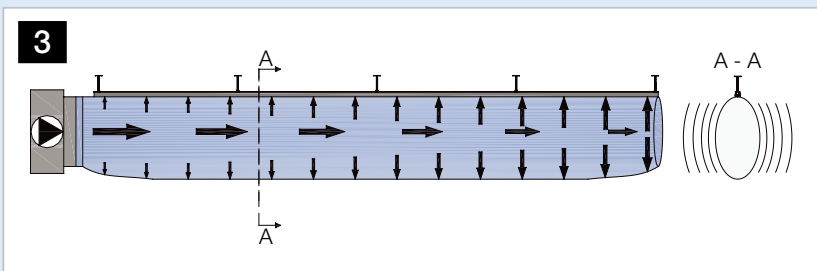
It is recommended that ventilation systems with textile ducting use a soft-starter, frequency converter or a control damper to ensure that the system starts up slowly. If this is not done the following sequence of events will occur:



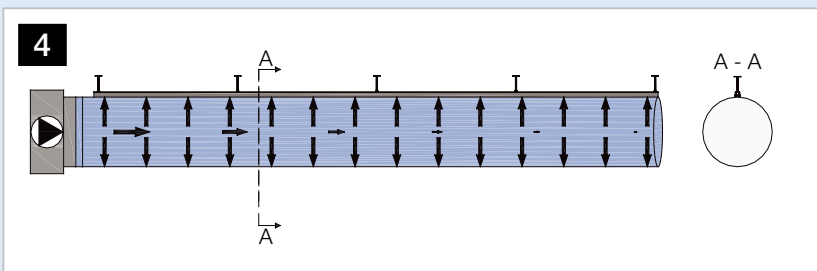
Round textile ducts hang straight down when the ventilation system is not in operation, with the ducts hanging down slightly compared to when the system is on. The ducts contain absolutely no air.



In simple systems controlled using an ON/OFF mechanism the fan will reach full capacity very quickly after start-up. As the duct is still hanging down loosely, the duct's cross-sectional area will be very restricted and the air velocity in the duct will therefore become very high. As no static pressure has yet built up in the duct, the horizontal air movement will generate a powerful wave motion travelling forward through the textile duct.



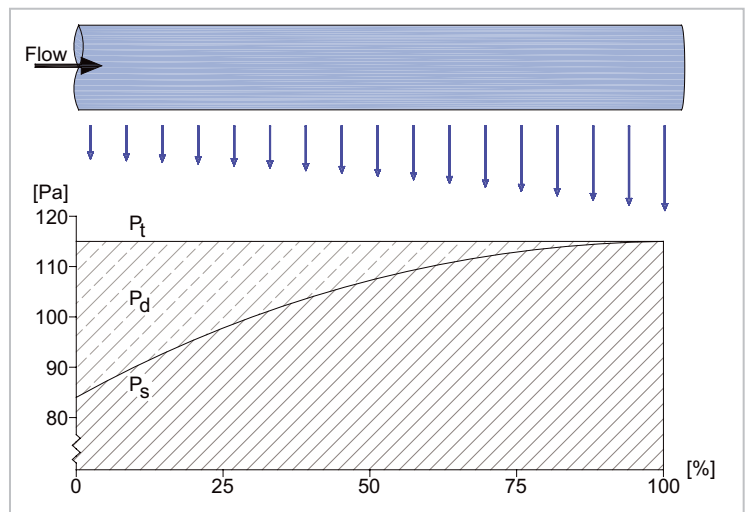
When the powerful horizontal air movement reaches the bottom of the textile duct, it will arrive with such force that it may cause the suspension system and textile duct to come loose with the vibration or even sustain serious damage. When the horizontal movement has reached the bottom of the duct, the static pressure in the duct will start to be exerted on the duct's sides and the duct will be inflated from the end back towards the fan. This generates a powerful wave motion travelling backwards through the textile duct.



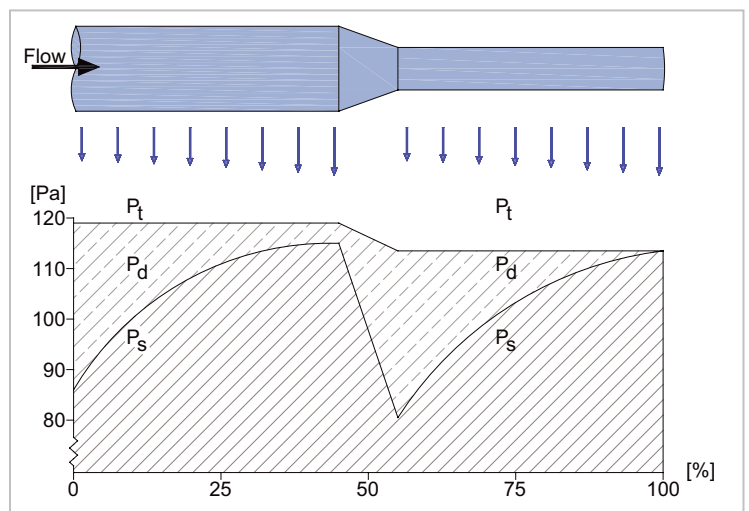
When the static pressure has built up to a normal level, the system will hang still, provided that the duct has been dimensioned correctly.

### $P_s/P_d$ RATIO

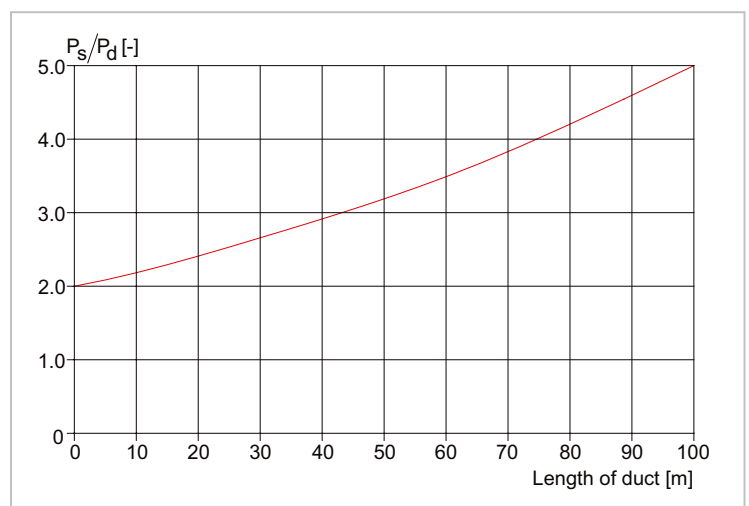
As a result of their permeable surface, the volume of air and air velocity in textile ducts, unlike in ordinary steel ducts, continually decreases along the duct. This means that the dynamic pressure falls along the duct, while the static pressure rises. This results in a large portion of the air being delivered at the end of the duct where the dynamic pressure is zero. As the volume of air continually decreases along the duct friction loss may often be ignored. This means that the total pressure and static pressure will be more or less identical at the bottom of the duct.

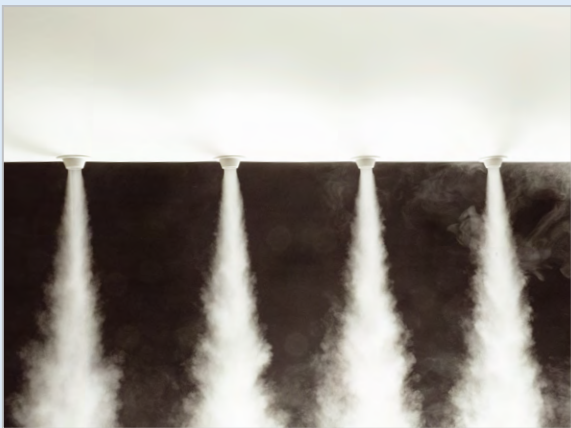
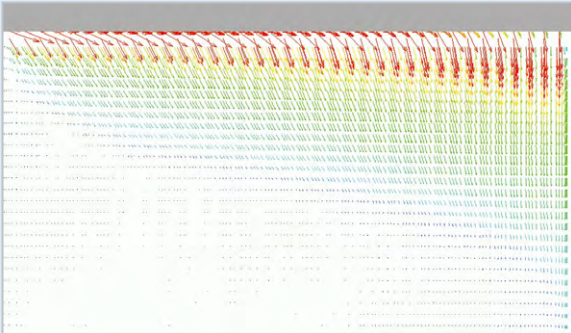
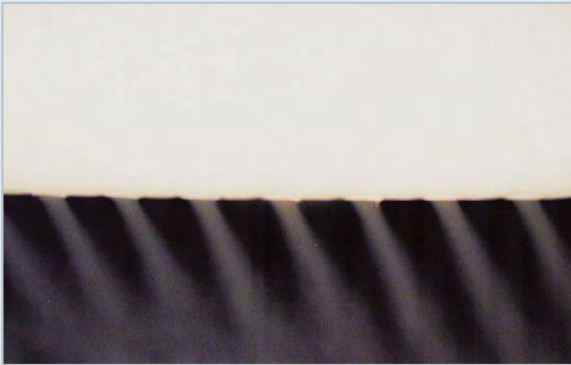


One solution frequently used to ensure that air is distributed uniformly through very long ducts is to restore the dynamic pressure in the system by inserting a duct reduction, in the middle of the duct, for instance. This will break the static pressure in the duct, thereby achieving a more even distribution of air. This is also the most economical solution if duct reductions are acceptable. To facilitate installation, single suspended ducts should have duct reductions with flat edge on top, while double suspended ducts should have centred duct reductions.



In order to produce a uniform distribution of air along the entire system's longitudinal direction, the static pressure in the middle of the textile duct should always be at least double that of the dynamic pressure in the duct's inlet. KE Fibertec recommends that the ratio between the static pressure,  $P_s$ , and dynamic pressure,  $P_d$ , should at least follow the curve on the right. The longer the duct is, the higher the static pressure needs to be in the middle of the duct in relation to the dynamic pressure in the inlet, in order to ensure that the air is distributed uniformly.





## ENTRAINMENT IN TEXTILE DUCTS

It is well known in flow engineering that holes positioned with a perpendicular direction in a long main duct can cause problems. The main problem is that the air has a tendency to veer away and flow parallel to the main duct, unless the holes or nozzles are fitted with baffle plates.

In the vast majority of cases, entrainment will cause problems with air distribution in the premises. At one end of the room (nearest the inlet), problems may arise with stagnant air, while at the other end of the room, entrainment may be the cause of major draught problems. Entrainment occurs if the inlet velocity is significantly higher than the outlet velocity through the holes in the textile material. To counter this inconvenient deflection of flow (entrainment), KE Fibertec recommends that the outlet velocity through the holes be at least 35% higher than the inlet velocity in the duct.

Another factor which has an impact on entrainment is the size of the hole that has been cut out. If air is supplied through large holes it will always have a tendency to deviate and flow along the duct.

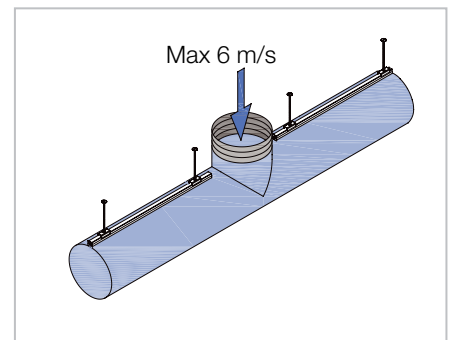
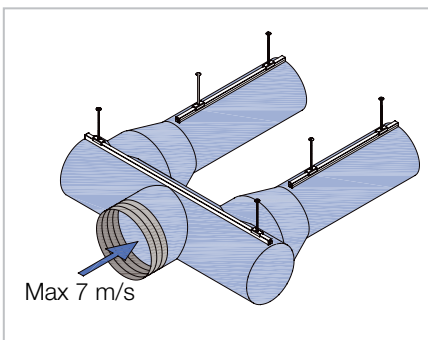
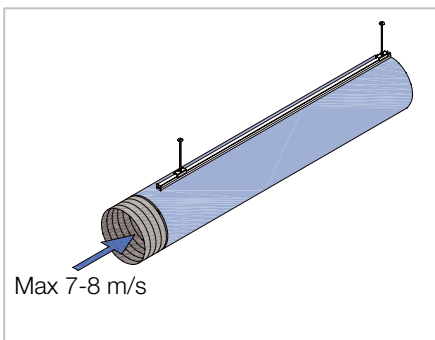
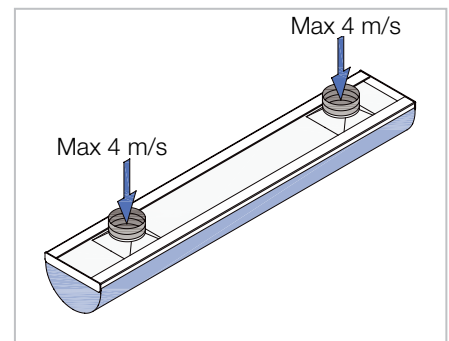
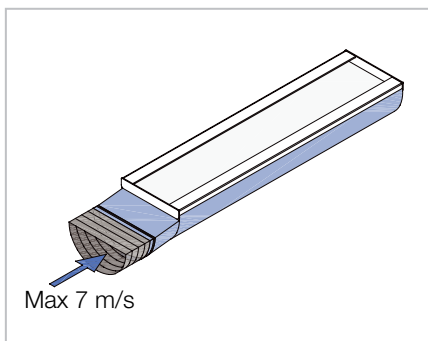
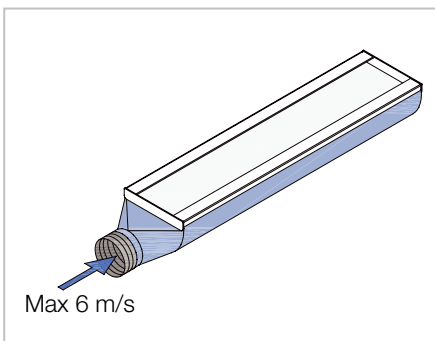
The KE-DireJet System never has problems with entrainment. The nozzles are designed with a length that ensures the air is discharged perpendicularly to the main duct. In the KE-Inject System the holes are cut directly in the textile, which means that the use of baffle plates is not an option. On the other hand, entrainment does not occur to such a noticeable extent in this case either. The reason for this is because the air velocity at the centre of the hole, i.e. perpendicular to the main duct, is usually higher in the KE-Inject System than in conventional systems.

## PERMEABILITY

Air permeability through the textile material's surface is crucial to how great the static pressure will be for a given volume flow. The tighter the material's weave, the higher the pressure will be as a function of volume flow. For all KE Fibertec's low impulse materials, the static pressure increase is given as a function of volume flow per  $m^2$  of the textile material's surface. Permeability is expressed in the unit  $[m^3/m^2/h]$ . See datasheet 6 for more information.

## MAXIMUM INLET VELOCITIES

The inlet velocity is a critical design parameter for textile based ventilation systems as it has a major impact on aspects such as pulsation, noise generation, the material's durability and the air distribution from the duct. The recommended inlet velocity for round ducts is no more than 6-8 m/s, depending on the entry method. In the case of KE-Interior Systems, air velocities of between 4 and 7 m/s may be permitted, depending on the entry method.



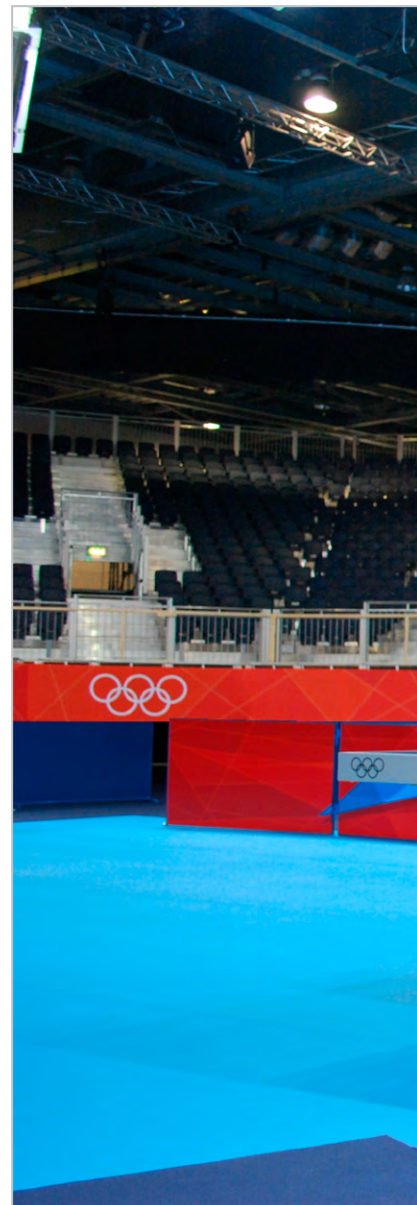
## OUTLET VELOCITIES – LOW IMPULSE

The outlet velocity through textile based low impulse systems depends on the geometric surface area as the air is slowly diffused through the whole surface of the textile material.

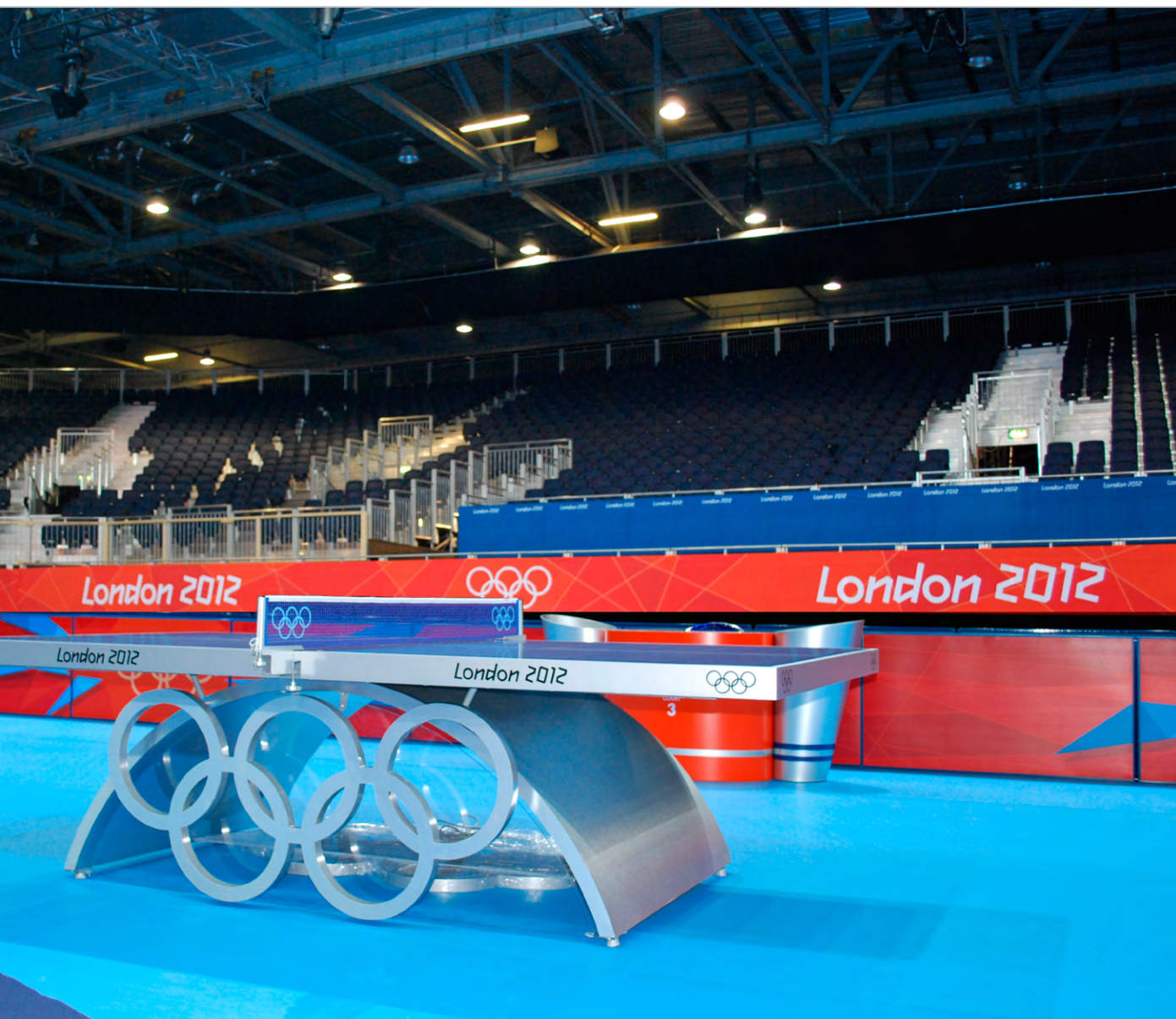
## OUTLET VELOCITIES – HIGH IMPULSE

The static pressure keeps the textile based ventilation system inflated, but the static pressure pushes the air out through the holes/nozzles and if necessary, through the textile material. The outlet velocity is a very significant parameter in the calculation of the throw length, thermal penetration length etc., but in reality, it is very difficult to measure. On the other hand, any calibrated manometer can be used to measure the static pressure in the duct. With a standardised hole design and a detailed knowledge of the properties of the holes and nozzles, any given outlet velocity will always correspond to the same static pressure in the duct.

As already described on the opposite page, the air velocity in the KE-Inject System must be adapted to the outlet velocity. The minimum requirement is for the outlet velocity to be 35% higher than the inlet velocity.



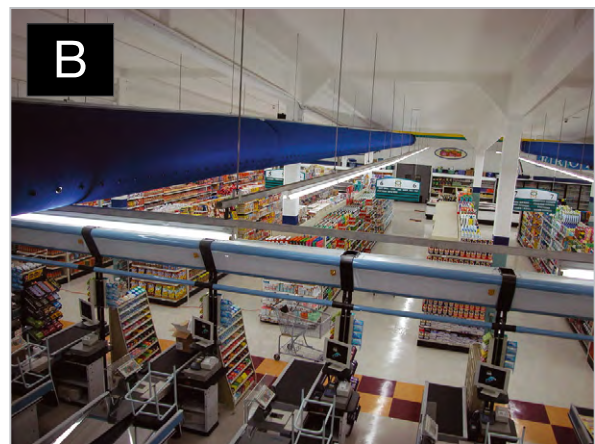
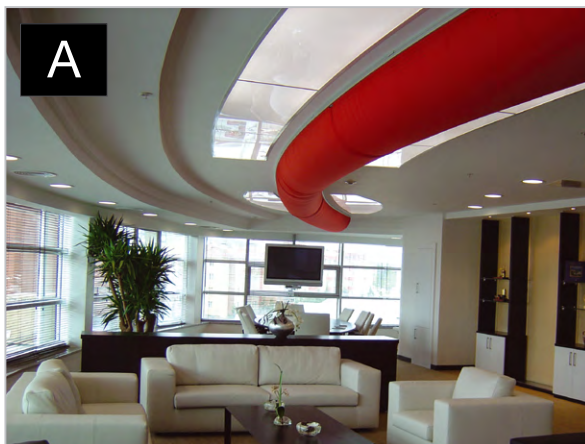
## 10. ROOM CATEGORIES



# ROOM CATEGORIES

## ROOM CATEGORIES

One of the key parameters during the design phase is determining the comfort requirements. A thorough needs analysis provides the basis for the design and a great deal of money can be saved by finding out what the end client's actual requirements are. Unfortunately, there are far too many examples where the quality of the solution delivered does not at all reflect the end client's expectations. To simplify the whole needs analysis process, KE Fibertec has developed KE-Room Categories, which compares the four key thermal indoor climate parameters when dimensioning textile based ventilation systems. The KE-Room Categories is a tool developed on the basis of Professor Fanger's comfort theories.



Indoor climate parameters	A	B	C	D
<b>Level of activity</b>	Sitting/standing	Standing/periodically motion	Slight motion/vigorous motion	No fixed workplaces
<b>Clothing</b>	Short sleeves/light trousers/light working clothes	Light jacket/sweater/shirt/trousers	Jacket/coat/boiler suit/sweater/shirt/trousers	As required
<b>Recommended air velocity in occupied zone</b>	0.15 m/s	0.20 m/s	0.25 m/s	> 0.30 m/s
<b>Temperature condition requirements in occupied zone</b>	Uniform (1-2°C)	Slight difference (2-3°C)	Major difference (4-6°C)	Variable (-)

## LOW IMPULSE SYSTEMS (HORIZONTAL)

		A	B	C	D
Recomm. $\Delta T$ (room - inlet)	[°C]	2.5-3.0	3.0-5.0	4.0-6.0	5.0-15.0
Max. $\Delta T$ (room - inlet)	[°C]	6.0	7.5	9.0	-
Velocity through textile surface:					
- KE-Low Impulse System	[m/s]	< 0.07	< 0.09	< 0.15	-
- KE-Interior System	[m/s]	< 0.09	< 0.11	< 0.18	-
Temperature difference:					
- Occupied zone		Uniform	Slight difference	Major difference	Variable
- Near zone		85-90 % mixing	65-75 % mixing	60-70% mixing	-
Max. variation in supply temperature	[°C]	± 0.5	± 1.0	± 1.5	-
Max. cooling load per running metre of textile duct at nom. $\Delta T^{(1)}$	[W/m]	260	700	1500	5,000
Max. cooling load per running metre of textile duct at max. $\Delta T^{(1)}$	[W/m]	95	175	200	-
Max. cooling load per m <sup>2</sup> of floor area	[W/m <sup>2</sup> ]	100-130	175-200	250-300	-
Recommended max. centre distance between ducts	[m]	2-4	4-8	5-10	5-10

<sup>(1)</sup> Installation height: 4 m up to the bottom edge of the duct. See datasheet 1 for other installation heights.

## HIGH IMPULSE SYSTEMS/HYBRID HIGH IMPULSE SYSTEMS

		A	B	C	D
Recomm. $\Delta T$ - KE-Inject:					
Cooling (room - inlet)	[°C]	4.0-6.0	6.0-8.0	8.0-10.0	10.0-15.0
Heating (inlet - room)	[°C]	3.0-5.0	4.0-6.0	5.0-7.0	8.0-12.0
Recomm. $\Delta T$ - KE-DireJet:					
Cooling (room - inlet)	[°C]	4.0-6.0	6.0-10.0	8.0-12.0	10.0-15.0
Heating (inlet - room)	[°C]	3.0-6.0	4.0-8.0	6.0-10.0	8.0-15.0
Recomm. min./max. room height KE-Inject System	[m]	3-4	4-6	4-6	-
Throw length (ST-2) <sup>(2)</sup>					
- KE-Inject LV	[m]	1.8	1.4	1.1	-
- KE-Inject MV	[m]	2.6	1.6	1.2	-
- KE-Inject JET	[m]	6.4	3.4	2.1	-
Recomm. min./max. room height KE-DireJet System					
- Ø12, Ø18, Ø24 mm	[m]	5-9	6-10	7-11	-
- Ø48, Ø60 mm	[m]	9-14	10-16	11-25	-
Throw length (ST-2) <sup>(2)</sup>					
- KE-DireJet Ø12 mm	[m]	5,6	4,3	3,5	-
- KE-DireJet Ø18 mm	[m]	8,3	6,3	5,1	-
- KE-DireJet Ø24 mm	[m]	13,1	9,9	8,0	-
- KE-DireJet Ø48 mm	[m]	23,6	17,8	14,3	-
- KE-DireJet Ø60 mm	[m]	26,1	19,7	15,8	-

<sup>(2)</sup> Throw length calculated for one row of holes and one nozzle respectively at 100 Pa static pressure. See datasheets 7-17 for further information.

Note: The tables are only intended as a guide. Please contact KE Fibertec for further information.



## 11. TYPICAL LAYOUTS



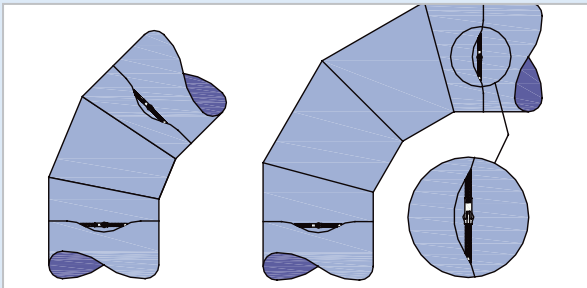
## DESIGN THE WAY YOU WANT

KE Fibertec's philosophy is to begin with our customer's actual requirement and from there devise a technical solution with the purpose of creating the perfect indoor climate. This is why we call it: DESIGN THE WAY YOU WANT! The important aspect of all our solutions is that the relevant room conditions are compared with an ideal solution model so that the layout selected for the system will ensure that the air is distributed as it is supposed to be, without any problems with draughts, pulsations or noise.

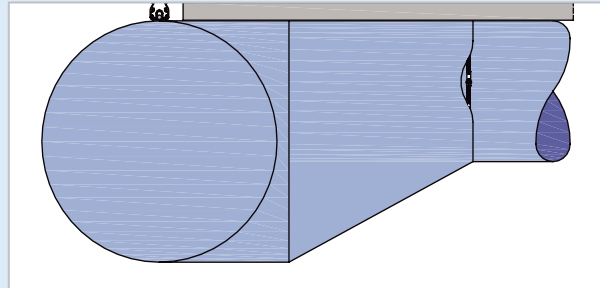
## ROUND DUCTS

A textile based ventilation system comprising round ducts can be assembled from many types of bends, elbows, fittings and offsets. What all the components have in common is that they are joined together using a zipper, providing a smart, practical solution. The figures below show different components which can be assembled to produce the final layout. Any angle can be selected for elbows and bends, and conical transitions and T-pieces can be produced in different designs.

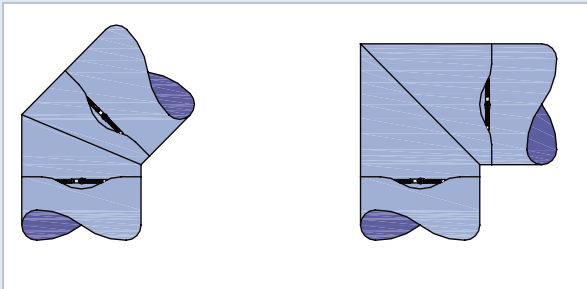
**BEND**



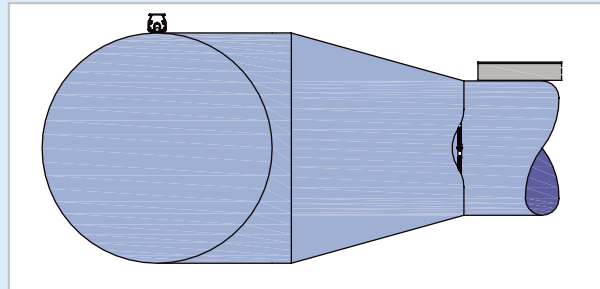
**FLAT EDGE ON TOP**



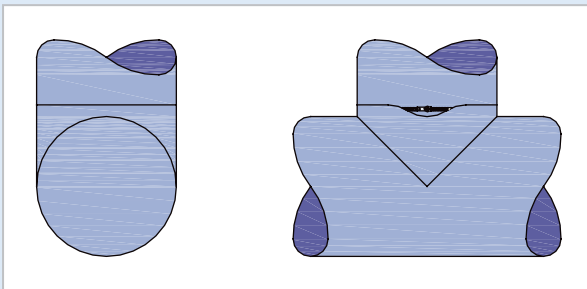
**ELBOWS**



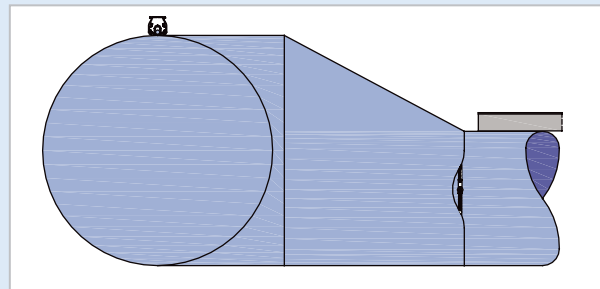
**CENTERED**



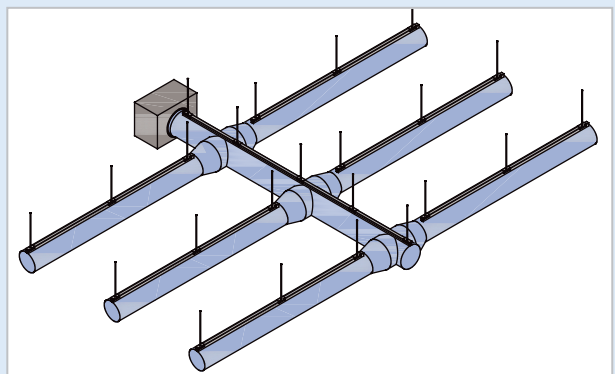
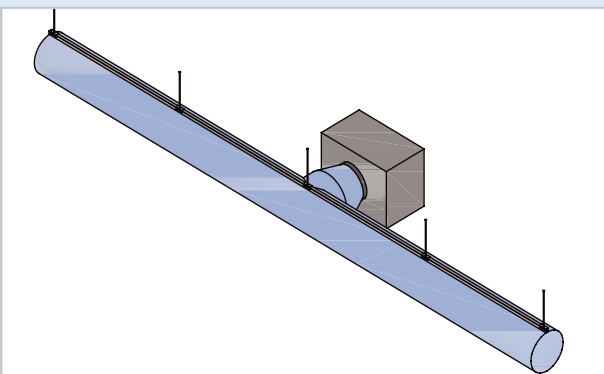
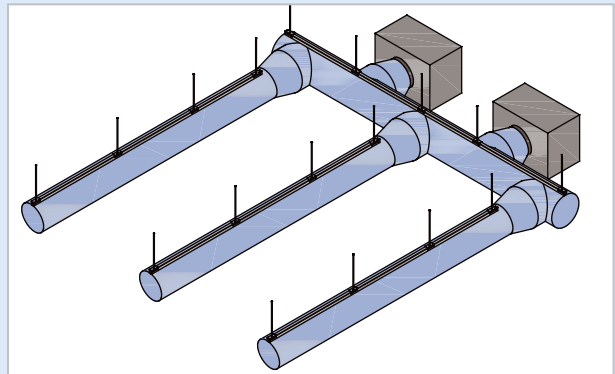
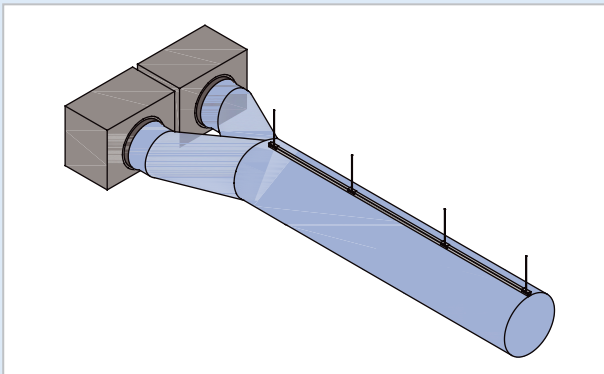
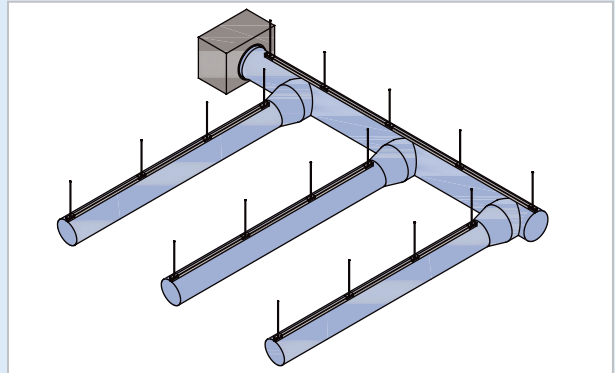
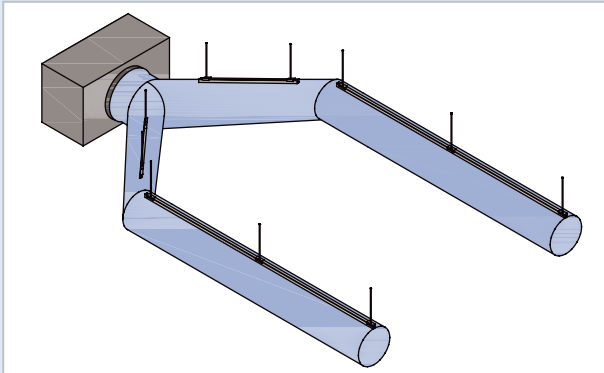
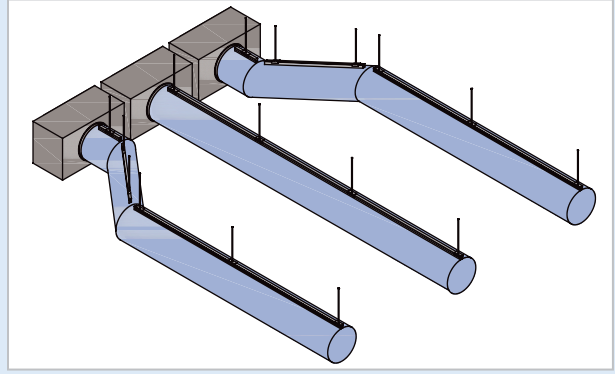
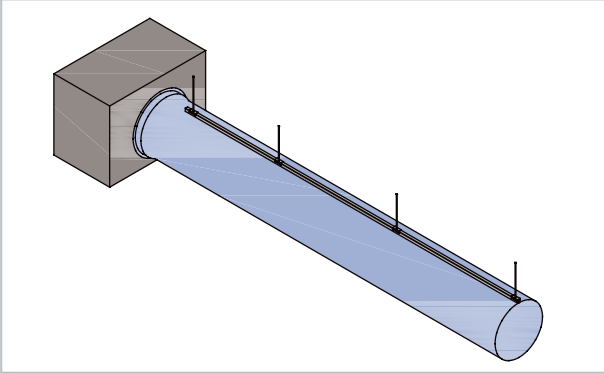
**T-PIECE**



**FLAT EDGE ON BOTTOM**



## EXAMPLES OF SYSTEM LAYOUTS USING ROUND DUCTS



# TYPICAL LAYOUTS

## EXAMPLES OF INSTALLATIONS USING ROUND DUCTS



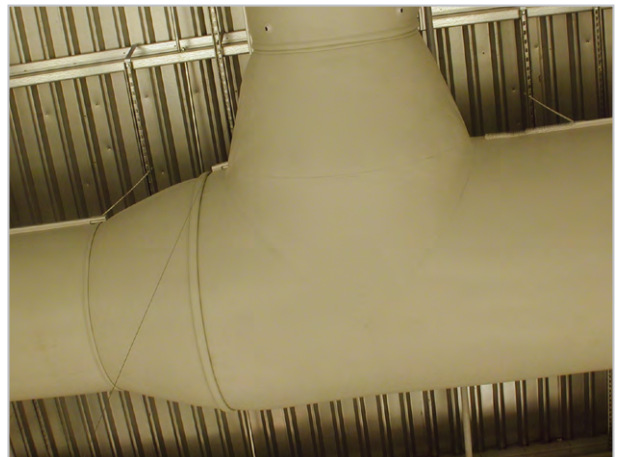
*Sample installation: 90° bends*



*Sample installation: Offset with 45° elbows*



*Sample installation: Attachment with offset on top using a 45° elbow*



*Sample installation: Conical transition and a T-piece with a conical transition (flat edge on top)*



*Sample installation: T-piece with a conical transition (flat edge on top) and 90° bend running upwards*



*Sample installation: 90° bends in two directions*

SPECIAL SYSTEMS - MANUFACTURED USING STANDARD COMPONENTS



*Astra-Zeneca: Loughborough, England*



*Bakery: the Netherlands*



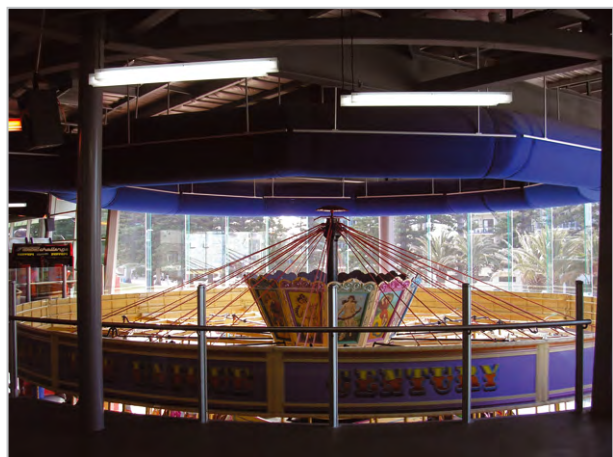
*Food terminal: Arla Foods, Sweden*



*Equalising room: Uppsala, Sweden*



*Hull University: Hull, England*



*Tivoli Park: Australia*

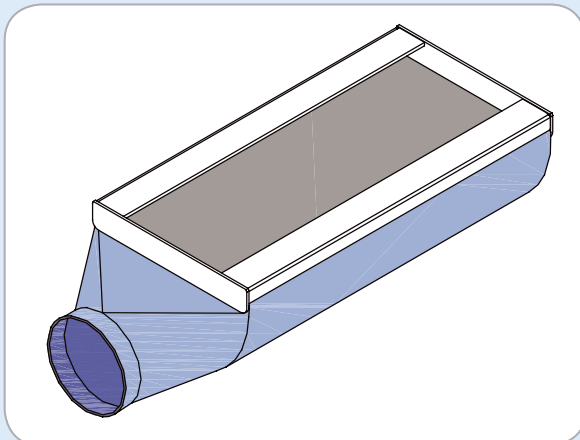
## D AND ½D-SHAPED DUCTS

D-shaped and ½D-shaped KE-Interior Systems have been specially developed for comfort ventilation, which is why there are often major requirements in terms of their finish. As a result, KE Fibertec puts great emphasis on the fact that these systems are highly flexible and can be produced using countless layouts. A KE-Interior System based on these ducts can, just like round ducts, be created using many types of bends, fittings and offsets, which are joined together using a zipper, providing a smart, practical solution.

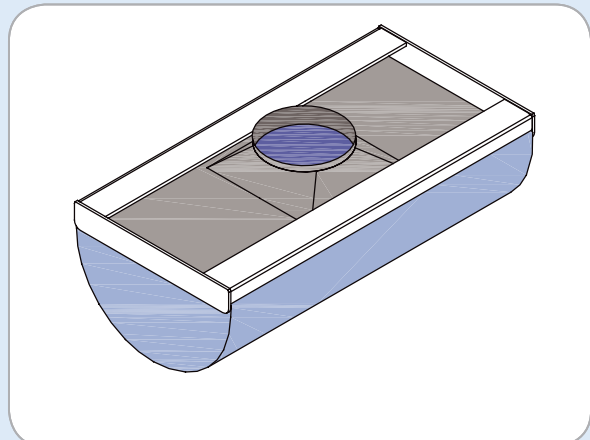
KE Fibertec offers a variety of air inlet options for KE-Interior Systems, specifically round inlet sockets, an inlet socket through the top, a D-shaped inlet socket and a rectangular socket can be used as part of the installation. In the case of false ceilings, it is recommended that the air inlet pass through the roof so that all the spiro ducting can be hidden. The top of the ducts (the roof) is obviously made from a textile material which will allow a little part of the air through. This will also prevent mould forming between the duct and ceiling.

D-shaped ducts can also be produced as curved ducts which are easy to include as an elegant architectural element in office buildings, canteens etc.

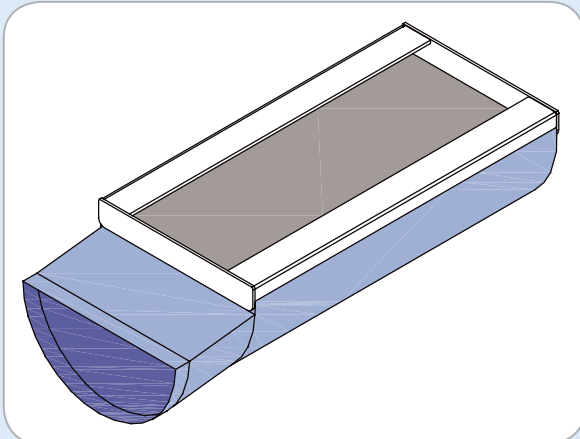
**ROUND INLET SOCKET AT END**



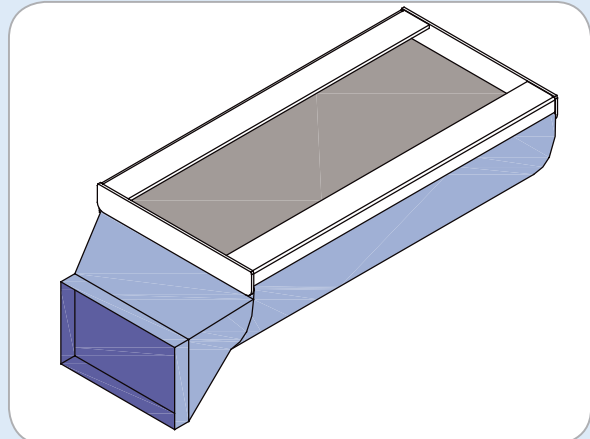
**ROUND INLET SOCKET IN ROOF**



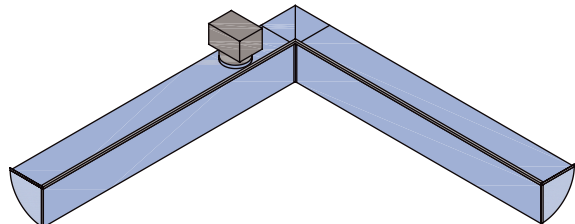
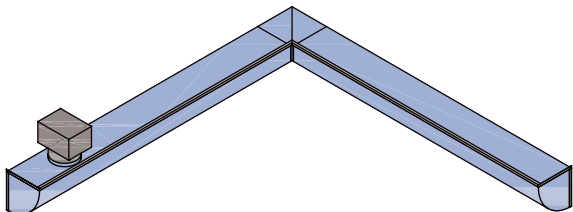
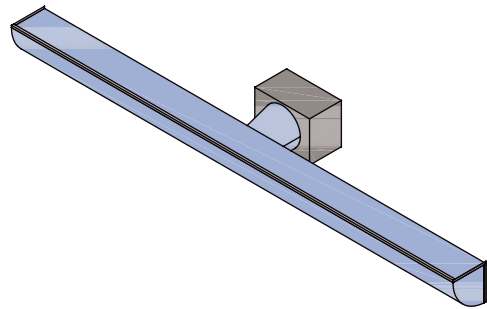
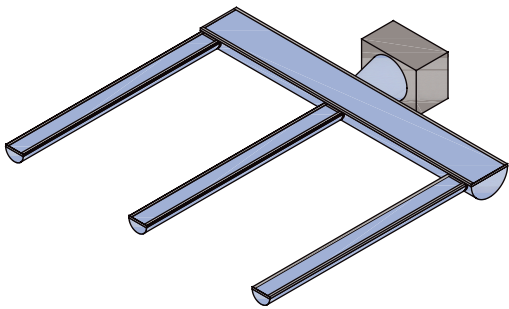
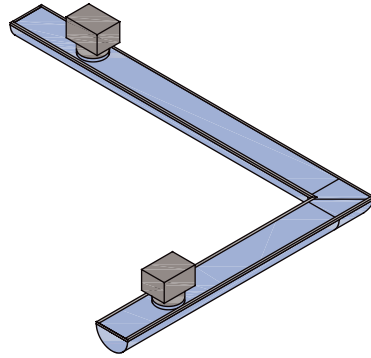
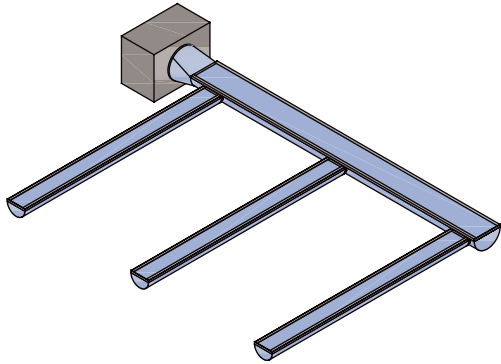
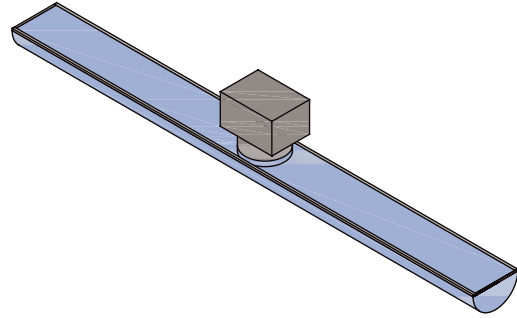
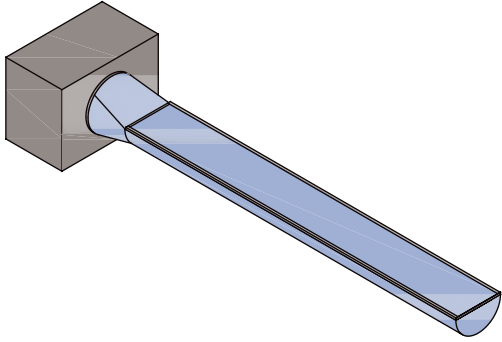
**D-SHAPED INLET SOCKET**



**RECTANGULAR INLET SOCKET**

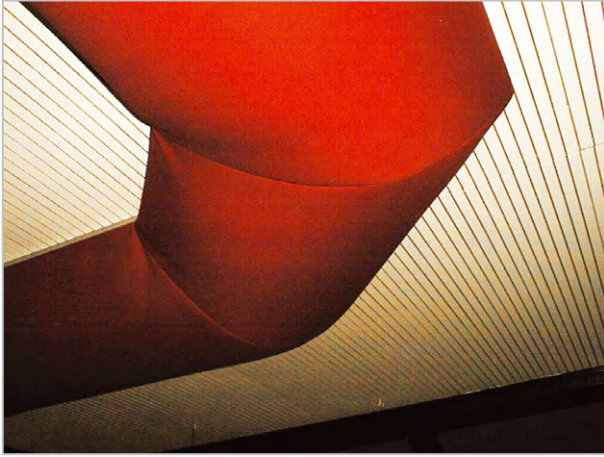


EXAMPLES OF SYSTEM LAYOUTS USING D AND ½D-SHAPED DUCTS



# TYPICAL LAYOUTS

## EXAMPLES OF INSTALLATIONS USING D AND ½D-SHAPED DUCTS



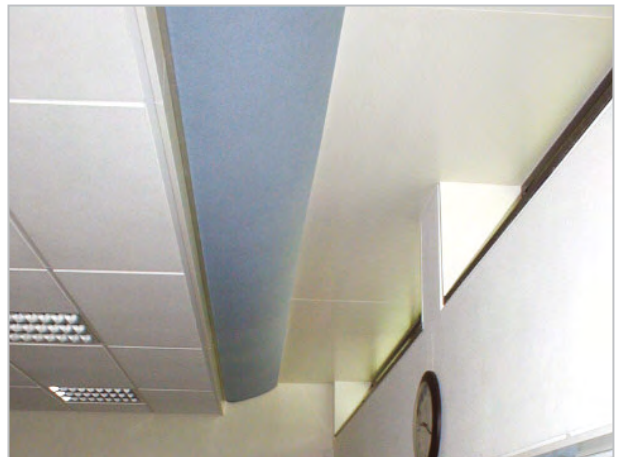
*Sample installation: 90° D-bend*



*Sample installation: Suspended D-duct*



*Sample installation: D-duct with a reduction and offset*



*Sample installation: ½D-duct with reduced height*



*Sample installation: ½D-duct with a printed logo*



*Sample installation: 90° elbow with bevelled rails*

SPECIAL SYSTEMS - MANUFACTURED USING STANDARD COMPONENTS



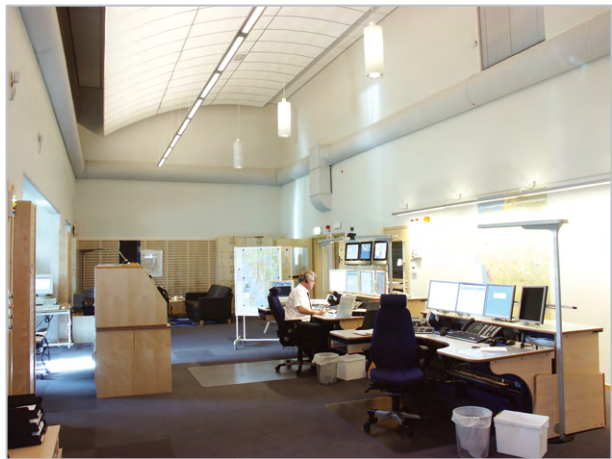
Canteen: Algida Unilever, Turkey



Office: Mediatheek Rotterdam, Netherlands



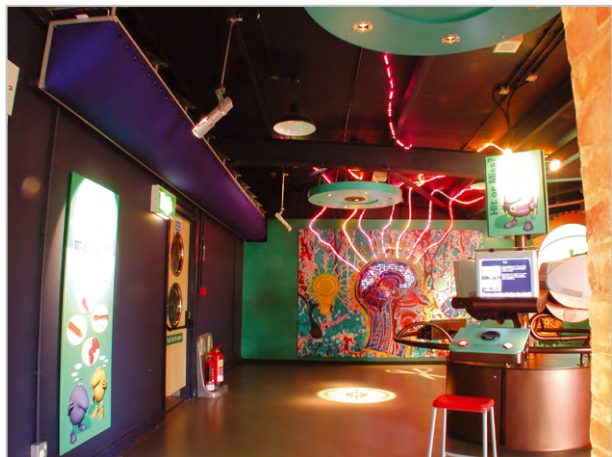
Restaurant: Menara Maxis, Malaysia



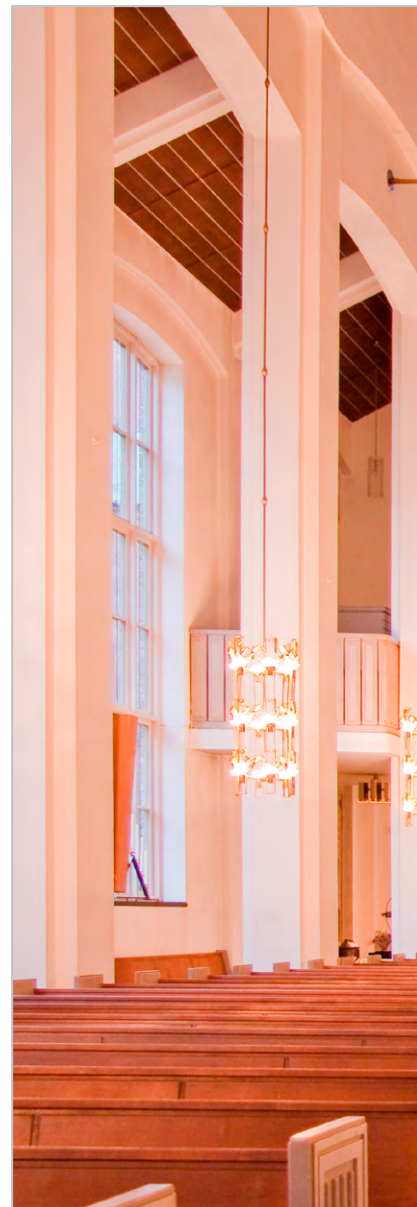
Fire station: Helsingborg, Sweden



Church: Middlesbrough, England



Discovery centre: Making It, England



## 12. SOUND LEVEL ASPECTS OF DESIGN



## SOUND CALCULATIONS

### What is sound?

*Sound is the vibration of air molecules in the atmosphere that can be sensed by the ear. As the air molecules are set in motion, they radiate outwards, colliding into other air molecules until they strike the ear drum.*

The relation between the sound power  $P$  and the sound power level  $L_w$  is described by the following expression:

$$L_w = 10 \times \log (P/P_{re})$$

Where:

$P$  Actual sound power transmitted [W]  
 $P_{re}$  Reference sound power ( $10^{-12}$  W)

The relation between the sound pressure  $p$  and the sound pressure level  $L_p$  is described by the following expression:

$$L_p = 20 \times \log (p/p_{re})$$

Where:

$p$  Actual sound pressure [Pa]  
 $p_{re}$  Reference sound pressure (20 mPa)

Room attenuation specifies the difference between the sound power level transmitted and the sound pressure level exerted in the room.

$$RA = L_w - L_p$$

Where:

RA Room attenuation [dB]

Noise is the name used in everyday parlance for unwanted sound, i.e. sounds that irritate, disturb or harm people. A well-dimensioned ventilation system must therefore make little noise! KE Fibertec considers it important to be able to document how much noise our TBV systems make. In this section a brief description of the theory behind the sound calculations is given.

### WHERE DOES NOISE COME FROM?

In a ventilation system the sources are noise from the actual installations, as well as noise generated by the air's movement. Noise generated by the installations originates mainly from the air conditioning system where fans generate noise. By the very nature of this phenomenon, KE Fibertec cannot say how much noise is transmitted by the air conditioning system. It is simply important to point out that this noise needs to be attenuated before it reaches the TBV system as textile ducting cannot attenuate fan noise. KE Fibertec's documentation applies to noise generated by the air's movements, i.e. noise created by the pressure drop/fluctuations which arise in the textile duct. In low impulse systems the inlet velocity is often the critical factor. In the case of KE Fibertec's high impulse systems, the outlet velocity through the holes or nozzles is often the critical factor.

### SOUND POWER & SOUND PRESSURE

The sound power  $P$  is a direct measurement indicating how much sound power a sound source is transmitting. The sound power is therefore directly linked to the sound source and is measured in watts (W).

The sound pressure  $p$  is a measurement of the sound's strength at a given distance from the source. It is characterised by the pressure vibrations which an ear picks up or is measured using a sound meter. Sound pressure expresses how the listener perceives the sound and largely depends on the location of the sound source and the room's acoustic properties. Sound pressure is measured in Pascals (Pa).

### SOUND POWER LEVEL & SOUND PRESSURE LEVEL

Given that the human ear's perception of sound is almost logarithmic, a logarithmic scale has been introduced to specify sound in the audible frequency range. As a result, when it comes to performing acoustic calculations, the concepts sound power levels,  $L_w$ , and sound pressure levels,  $L_p$  are used.

The sound power level  $L_w$  is linked to the sound source and is independent of the room's acoustics. The sound power level is expressed in decibels (dB). The sound pressure level  $L_p$  is directly dependent on the sound power level and expresses how the listener perceives the sound. It largely depends on the location of the sound source and the room's acoustic properties. The sound pressure level is expressed in decibels (dB).

### ROOM ATTENUATION

Room attenuation specifies the difference between the sound power level transmitted and the sound pressure level exerted in the room. This means that the sound pressure level is obtained by subtracting the room attenuation (RA) from the sound power level generated by the source.

## WHAT INFLUENCES THE NOISE IN THE ROOM?

Unlike the sound pressure level, the sound power level is a product-specific value. As a result, the TBV system's acoustic features are specified at a particular sound power level. If the sound pressure level also needs to be used, the room attenuation has to be estimated.

Room attenuation is, as stated on the opposite page, an expression of the difference between the sound power level transmitted and the sound pressure level exerted in the room. Room attenuation is, by its nature, very complicated to calculate properly as it depends, e.g.:

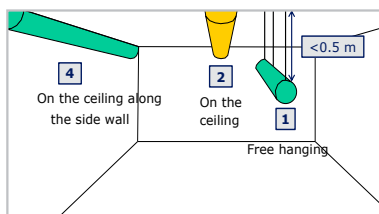
- Geometry and dimensions of the room
- The room's surface characteristics
- Location of the textile ducts
- Number of textile ducts
- Distance from the source to the recipient

When a sound is emitted from a sound source, it is received in the room as either direct sound or reflected sound. The further away the location of the source, the less the direct sound will contribute to the overall sound pressure level perceived by the ear. The reflected sound will be of the same magnitude throughout the whole room and depends on the room's soundproof properties, which can be described as an equivalent absorption area (A). The absorption area is specified in the unit m<sup>2</sup> Sabine.

The most reliable method for determining the room attenuation is to take measurements of the reverberation time in the relevant room. However, as it is rarely possible to do this during the design phase the room attenuation can be estimated by using diagrams. These diagrams are shown in datasheet 21.

Diagram 1 operates by using the relevant room's volume as an input parameter for finding the equivalent sound absorption area (A). The distance from the textile duct (r) is then used, along with the directivity coefficient (D) to determine the room attenuation (RA). The directivity coefficient can be estimated based on the table below.

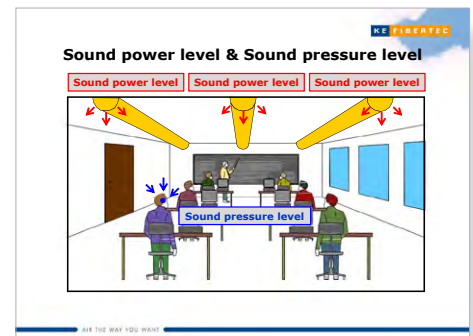
Type of textile duct	Directivity coefficient
Free hanging	1
On the ceiling	2
On the ceiling along the side wall	4



As shown in the above table, the directivity coefficient for D-shaped ducts fitted in the ceiling will always be 2 or 4, depending on whether the duct hangs in the middle of the room or along a wall.

## What is noise?

Noise is undesirable sound that causes damage or is troublesome. We each experience noise in different ways.



## What is sound power level?

The sound power level,  $L_w$  is measured in dB and is the acoustic energy emitted by the sound source. It is not affected by the surroundings.

## What is sound pressure level?

The sound pressure level,  $L_p$  is measured in dB and quantifies the magnitude of sound. The sound pressure level is influenced not only by the power of the source but also by the surroundings and the distance from the source to the recipient.

## What is decibel?

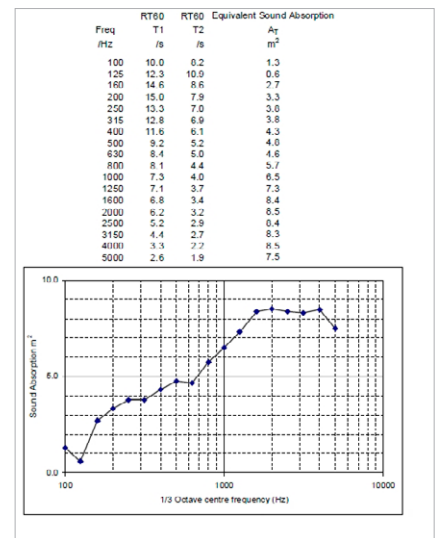
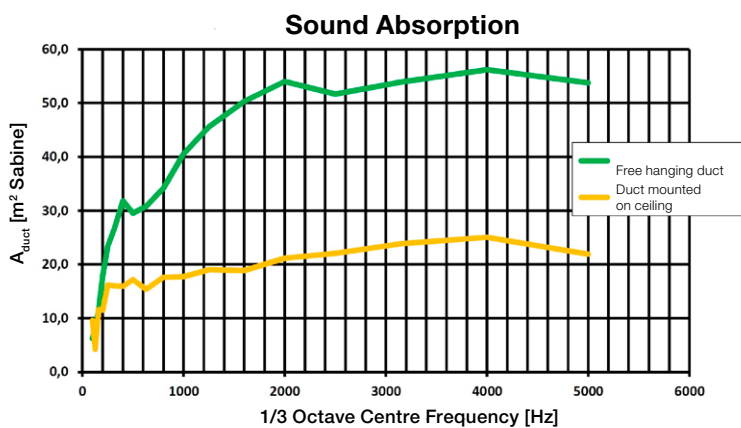
Decibel (dB) is a logarithmic unit used for expressing the ratio of two powers. The most common use is in measuring sound power level and sound pressure level.



” Because of their soft surface, textile ducts always have a positive impact on room attenuation as they act as a kind of sound absorber in the ceiling, absorbing and breaking up part of the sound reflected in the ventilated room. ”

## CASE: WALKDEN HIGH SCHOOL, UK

Walkden High School's new building was constructed as part of BSF, Building Schools for the Future. To ensure that the class rooms would not receive any unnecessary noise from the ventilation ducts the consulting engineers requested a noise test in order to establish how much noise is absorbed by textile ducts. The test was performed by the University of Southampton for the purpose of establishing the room attenuation effect through textile ducts. KE Fibertec's R&D department has carried out their own "equivalent absorption" calculation based on the results from the testing done at the University of Southampton.





[ke-fibertec.com/walkden](https://ke-fibertec.com/walkden)



*When a sound wave disseminates in the air and hits a material, e.g., a wall, a portion of this energy is reflected. Some will be transmitted through the wall and some will be absorbed by the wall and transformed into heat energy.*

Read the case at [ke-fibertec.com/walkden](https://ke-fibertec.com/walkden).

## SOUND REQUIREMENTS

There is often a requirement for a maximum noise level in an occupied zone. This requirement depends on how the room is used and how regularly. It is often specified as an  $L_{pA}$  value or an NR value.

The  $L_{pA}$  value specifies the A-weighted sound pressure level which is standardised using an A-filter. The A-filter makes an adjustment for the human ear's different perception of the sound, with the high tones being assigned the most weight. All KE Fibertec's sound data is adjusted using the A-filter, see the table below:

	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
<b>A-Filter</b>	-26	-16	-9	-3	0	1	1	-1



Originally  $L_{pA}$  values would be applied up to 55 dB,  $L_{pB}$  values would be applied within the range of 55-85 dB, and the  $L_{pC}$  values would be applied above 85 dB, however, most often it is the A value range that is applied.



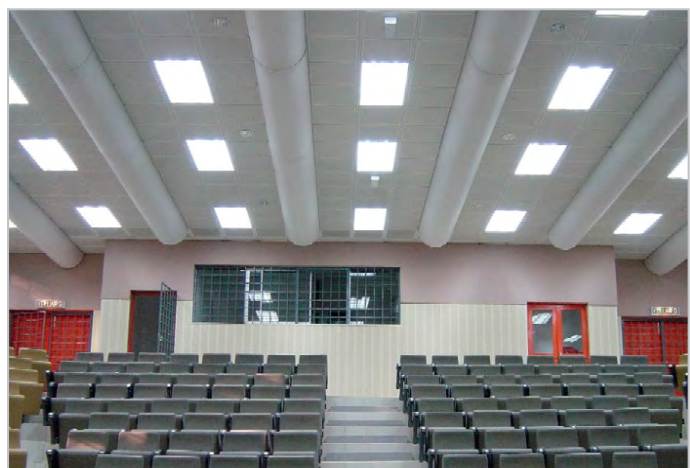
In the specific standards for mechanical ventilation systems, recommended design values most often are specified for the maximum A-weighted sound pressure level in different premises.

NR is short for Noise Rating. NR curves are approximately weighted to the human ear's perception of sound and are standardised in accordance with the International Organization for Standardization (ISO). As a general rule of thumb, the following expression can be used for NR:

$$NR = L_{pA} - 5$$

## SOUND MEASUREMENTS

All KE Fibertec's sound data is based on relevant noise measurements. We have collaborated with the acoustic laboratory Peutz & Associates B.V. in the Netherlands and HN AKUSTIK AB in Sweden to carry out a noise test on our textile based ventilation systems. The noise measurements have been taken in accordance with the requirements in ISO 3741 (Acoustics – Determination of sound power levels of noise sources using sound pressure – Precision methods for reverberation rooms) and ISO 5135 (Acoustics – Determination of sound power levels of noise from air-terminal devices, air-terminal units, dampers and valves by measurement in a reverberation room).



## SYSTEM DESIGN

The sound power level generated by low impulse systems is dependent, to some extent, on the inlet's location and, to a large extent, on the air's inlet velocity. In the case of KE Fibertec's high impulse systems, the generated sound power level is particularly dependent on the outlet velocity through the holes/nozzles, as well as on how many holes/nozzles per running metre of ducting are used.

There are innumerable possible ways of combining KE Fibertec's textile based ventilation systems. For this reason, it is obviously not possible to carry out a noise test for every combination. Instead of this, a basic sound power level is used for the specific duct. This sound power level must be corrected later on so as to match the relevant layout.

The basic sound power level can be taken from datasheet 18 once the total pressure loss for the textile based system is known. It should be noted that this is the overall pressure loss for the textile ducts only. After this, the basic sound power level must be corrected for the relevant layout of the system. This is done by using the duct length and the relevant number of hole rows,  $r$ , or the total number of nozzles and the duct length as an input parameter in datasheets 19 and 20 where the correction value in dB is taken from. The correction value must be added or subtracted from the basic sound power level.

It is recommended allowing KE Fibertec to perform the final noise calculation for the specific installation. The noise calculation is performed automatically in our 3D dimensioning program WinVent, in the same way as for the pressure losses, air velocities etc.

## SAMPLE CALCULATION

We will start with the value for a KE-Low Impulse System calculated in Chapter 14. It is assumed that room attenuation can be calculated based on a normally attenuated room.

Maximum sound pressure level in room: 25 dB (A)

Input parameters from datasheet 18:  $P_t = 118 \text{ Pa}$ , basic sound power level: = 28 dB(A)

Correction for duct length:

Input parameters from datasheet 20:  $L = 9 \text{ m}$ , Correction (approx.): + 3 dB(A)

Resulting sound power level per duct:  $28 \text{ dB(A)} + 3 \text{ dB(A)} = 31 \text{ dB(A)}$

Resulting sound power level transmitted to room:  $31 \text{ dB(A)} + 3 \text{ dB(A)} + 2 \text{ dB(A)} = \underline{\underline{36 \text{ dB(A)*}}}$

Input parameters from datasheet 21 top: Room volume =  $825 \text{ m}^3$ , normal room

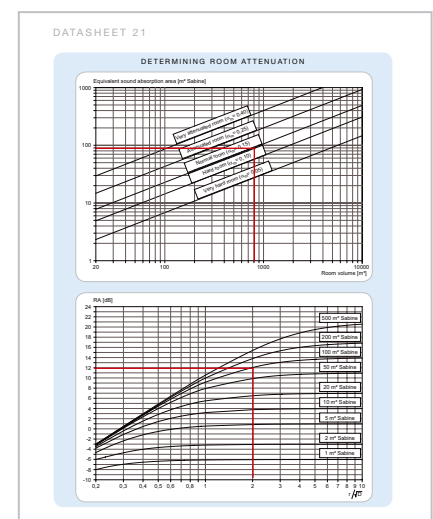
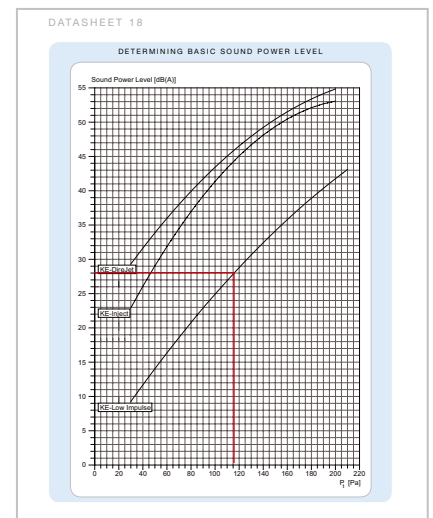
Result: Equivalent sound absorption area =  $90 \text{ m}^2$  Sabine

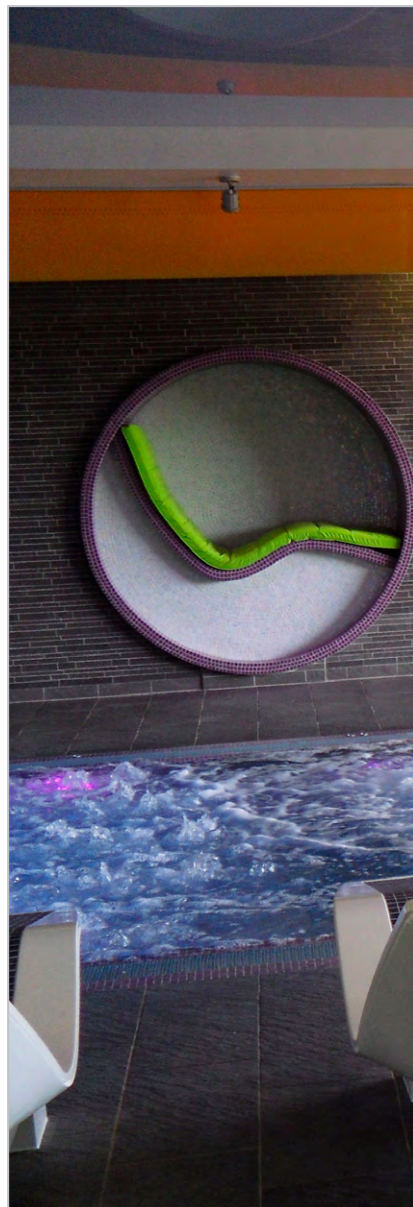
Input parameters from datasheet 21 bottom:  $r = (4.8 \text{ m} - 1.8 \text{ m}) = 3 \text{ m}$ ,  $D = 2$  (placed on the ceiling)  $r / \sqrt{D} = 3 / \sqrt{2} = 2.1$

Value taken for room attenuation:  $RA = 12 \text{ dB(A)}$

Resulting sound pressure level in room:  $36 \text{ dB(A)} - 12 \text{ dB(A)} = \underline{\underline{24 \text{ dB(A)}}} < 25 \text{ dB(A)} \quad \text{OK!}$

\*A logarithmic addition of the sound power levels is performed.





## 13. MATERIALS AND COLOURS



## STATE-OF-THE-ART MATERIALS

To ensure that KE Fibertec's stringent quality requirements are met, all its textile materials are woven at KE Fibertec's own weaving mill, KE Fibertec Væveri AS. This allows us to ensure that the entire process from yarn to finished product has gone through our ISO 9001 quality assurance system. KE Fibertec Væveri currently uses the latest technology, including a state-of-the-art air-jet looms. This means that KE Fibertec's weaving mill is able, in collaboration with our development department, to develop new and better materials at any time, all for the benefit of the finished fabric's quality and of the end user too.

## QUALITY FROM YARN TO PRODUCT

KE Fibertec Væveri manufactures more than 40 different product varieties from Trevira CS polyester materials woven in 10 different permeabilities and in different colours, to antistatic materials and Nomex special blends. KE Fibertec uses only dyed and heat-treated yarns, which are heat-fixed under constant supervision in order to achieve the most uniform and shrink-stable product possible. As a result, we are now able to offer the best guarantee on the market of maximum shrinkage of 0.5%. All the materials are also permeability-stabilised, which ensures the proper passage of air even after washing. This is absolutely crucial to the function of the textile ducts. For example, large variations in permeability will lead to excess consumption of energy if the material's weave is too tight or to pulsations around the inlet because the material's weave has become too loose.

KE Fibertec markets the following materials for our TBV systems:

- 7 types of HDC polyester material, Trevira CS
- 5 types of LDC HT (High Tenacity) polyester material
- 5 types of fire-retardant Nomex material
- 3 types of antistatic material, Trevira CS
- 2 types of clean room material
- 1 type of impermeable material (coated fabric)



## FIRE-APPROVED MATERIALS

KE Fibertec exclusively uses Trevira CS polyester fabric, which meets the requirements for flame retardant materials and is fire approved according to EN 13501\*, SIS 65 00 82 (Denmark, Sweden), DIN 4102-B1 (Germany), NFP-92501-1-M1 (France), UL-NFPA 90A-1993 (USA), MoD HH52/92 (UK) and EN 13501-1:2002.

Country	Standard	Classifications	Trevira CS
Denmark, Sweden	EN 13501-1 SIS 65 00 82	Flame retardant	B-s1-d0 Passed
Germany	DIN 4102	A = Non-flammable B1 = Flame retardant B2 = Normal combustibility B3 = Highly flammable	B1
USA (UL)	NFPA 90A-1993		Approved
France	NFP 92501-1	M0 = Non-flammable M1 = Non-combustible M2 = Flame retardant M3 = Flammable	M1
UK	MoD HH52/92	Flame retardant	Approved

\* Preliminary standards text: Textile based ventilation ducts shall be made of materials that conform with material B-s1-d0 acc. to EN 13501-1. However, up to 5% surface area may be fitted with plastic nozzles etc. of material class F, provided it is encircled by material of class B-s1-d0.



“ Fire approval certificates may be requested by contacting KE Fibertec AS. ”

## OEKO-TEX-CERTIFIED MATERIALS

KE Fibertec holds important certificates, such as Oeko-Tex 100, which document, for instance, our materials' content of harmful substances. Our textile materials comply with the most stringent limits for harmful substances and can therefore be put at the top of the best product class no. 1. Consequently, the Oeko-Tex 100 certificate provides our guarantee for the following:

- Our materials do not contain allergenic substances
- Our materials comply with the requirements concerning the limits for pesticides in the food industry
- Our materials do not contain any heavy metals
- Our materials do not contain dyes which may be carcinogenic
- Our materials comply with the most stringent formaldehyde requirements
- Our materials have a balanced pH-value (4.0-7.5)

Contact KE Fibertec for further information.

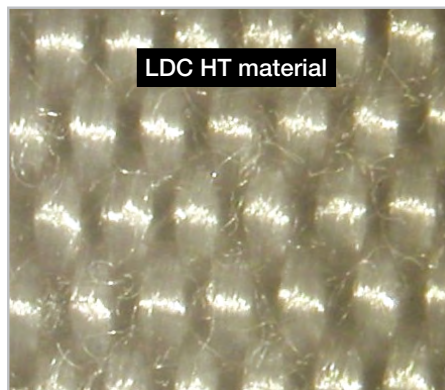
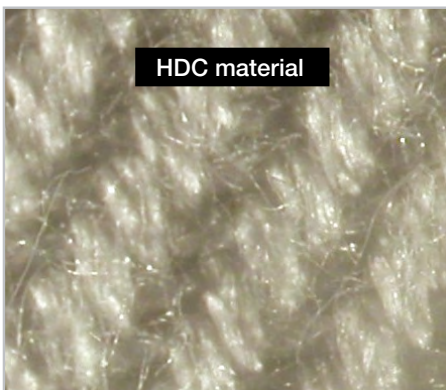


## MATERIALS' DUST HOLDING CAPACITY

No matter how well the air is pre-filtered, a certain amount of dust particles will always end up in the supply air. How frequently the textile ducting is washed therefore depends, to a large extent, on the fabric's dust holding capacity. KE Fibertec classifies the materials into two material groups according to the fabric's dust holding capacity. We therefore use the acronyms HDC for materials with a high dust holding capacity and LDC for materials with a low dust holding capacity.

” The surface structure of an HDC material compared to an LDC HT material. The HDC material has a huge surface and volume in relation to an LDC HT material, which is of great benefit to the dust holding capacity and therefore, the washing frequency. ”

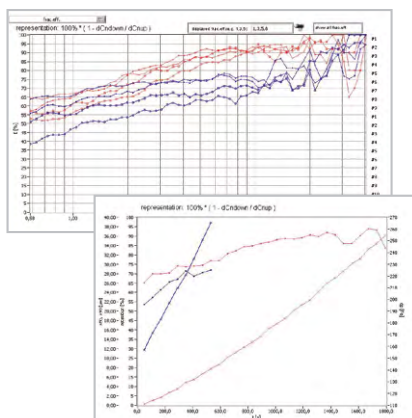
The capability of the materials to carry dust is highly dependent on the structure of the weave. High Dust Capacity materials (HDC) are made of staple fibre yarns, i.e. yarns that are spun of 38 mm long thin fibres. The final yarn is made by twisting two yarns into one yarn that is used both in warp and weft direction (length- and crosswise of fabric). The result is a fabric that is capable of carrying a large amount of dust without blocking the air flow through the material. Such blocking would require washing of the textile duct to ensure the distribution of the calculated quantity of air at the calculated pressure loss.



Low Dust Capacity materials are woven of multifilament warp yarns (lengthwise), i.e. yarns that are made up of 128 thin uncut fibres. These fibres are plain and smooth with a small surface compared to that of the staple yarns. In weft direction (crosswise), the same staple yarns are used as for the HDC fabric, however, the weaving-method is a more simple cotton bond with a much smaller surface than that of the HDC fabric.

In practice there will be no difference in strength or in durability of the two fabrics. Neither in permeability accuracy nor shrinkage.

KE Fibertec offers a variety of product types according to the relevant needs and type of installation. All low impulse systems and hybrid high impulse systems are basically dimensioned using materials with a high DHC, whereas we use materials with a lower DHC for very active systems (more than 30% of air through holes or nozzles). The reason for this is that the dust particles in these systems do not cause the same rise in pressure in the duct as most of the dust just penetrates the holes or nozzles.



KE Fibertec always carries out recommended tests on the dust holding capacity of textile materials. For instance, we have tested both HDC materials and LDC materials in accordance with EN 779 at the approved PALAS Institute in Germany. The results of these tests showed that the Dust Holding Capacity was up to 4 times higher for the HDC material compared to the LDC material.

## HIGH DUST HOLDING CAPACITY MATERIALS (HDC)

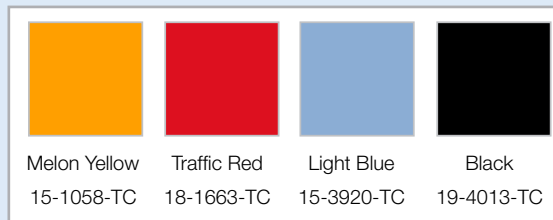


KE no.	Designation	Permeability at 120 Pa m <sup>3</sup> /m <sup>2</sup> /h	Material datasheet
025700	Trevira CS Polyester fabric	50	1
025710	Trevira CS Polyester fabric	150	2
025020	Trevira CS Polyester fabric	200	3
025030	Trevira CS Polyester fabric	320	4
025500	Trevira CS Polyester fabric	500	5
025600	Trevira CS Polyester fabric	780	6
022400	Trevira CS Polyester fabric	1380	7

### BASIC COLOURS



### STANDARD COLOURS

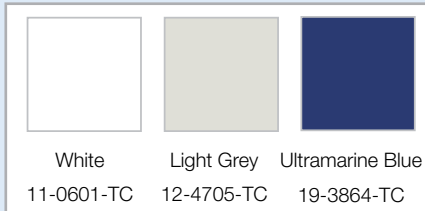


## LOW DUST HOLDING CAPACITY MATERIALS (LDC HT)



KE no.	Designation	Permeability at 120 Pa m <sup>3</sup> /m <sup>2</sup> /h	Material datasheet
025530	Flame retardant special Polyester fabric	40	41
A25530	Flame retardant special Polyester fabric Antimicrobial treatment	40	42

### BASIC COLOURS



### STANDARD COLOURS



KE no.	Designation	Permeability at 120 Pa m <sup>3</sup> /m <sup>2</sup> /h	Material datasheet
025520	Flame retardant special Polyester fabric	20	40
025550	Flame retardant special Polyester fabric	80	43
025580	Flame retardant special Polyester fabric	320	44

### BASIC COLOURS



## NOMEX MATERIALS



### BASIC COLOURS



Natural  
11-0701-TC



Midnight Blue  
19-4023-TC

KE no.	Designation	Permeability at 120 Pa m <sup>3</sup> /m <sup>2</sup> /h	Material datasheet
013521	Nomex fabric	130	33
013522	Nomex fabric	290	16
013523	Nomex fabric	370	17
013524	Nomex fabric	460	18
013525	Nomex fabric	700	19

## ANTISTATIC MATERIALS



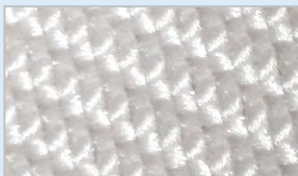
### BASIC COLOUR



White  
11-0601-TC

KE no.	Designation	Permeability at 120 Pa m <sup>3</sup> /m <sup>2</sup> /h	Material datasheet
035020	Trevira CS Antistatic	200	20
035030	Trevira CS Antistatic	320	21
035500	Trevira CS Antistatic	500	22

## CLEAN ROOM MATERIALS



### BASIC COLOUR



White  
11-0601-TC

KE no.	Designation	Permeability at 120 Pa m <sup>3</sup> /m <sup>2</sup> /h	Material datasheet
012586	Multi-filament Polyester fabric	320	23
012587	Multi-filament Polyester fabric	780	25

## COATED POLYESTER FABRIC FOR MIXING SYSTEMS



KE no.	Designation	Permeability at 120 Pa m <sup>3</sup> /m <sup>2</sup> /h	Material datasheet
026400	PVC-coated Polyester fabric	0	26
026500	PU-coated Polyester fabric	0	27

### BASIC COLOURS



### CUSTOM COLOURS

KE Fibertec can supply TBV systems in up to 1600 custom colours. Contact KE Fibertec's sales department for further information.

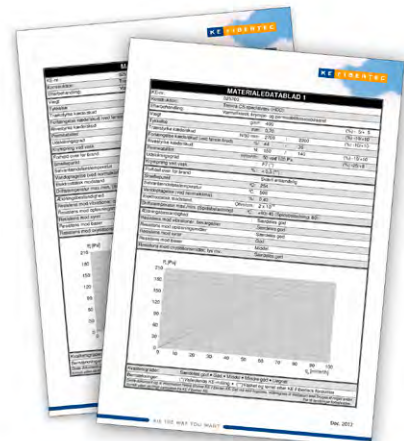


### LOGO ON TEXTILE DUCTS

Print or embroidery of logos or text is a new and different way of integrating the textile ducts in e.g. a showroom. Contact KE Fibertec for further information.

### MATERIAL DATASHEETS

KE Fibertec can provide material datasheets containing detailed information and documentation about each of the textile materials in our range. See our datasheets at [ke-fibertec.com/download](http://ke-fibertec.com/download) or contact us for further information.





## 14. DESIGN PROCESS



## PRACTICAL EXAMPLES

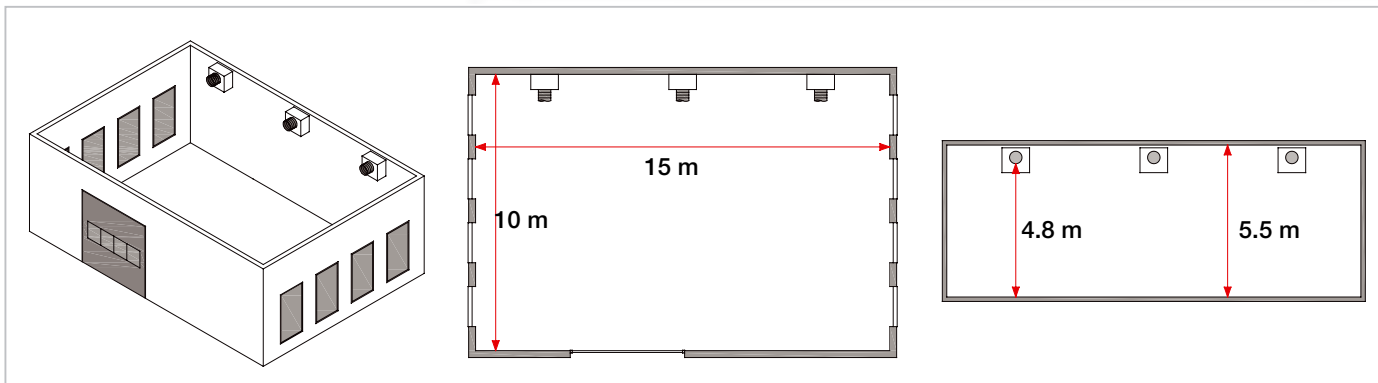
The examples below present quick estimated calculations for a KE-Low Impulse System, KE-Inject System and a KE-DireJet System. It goes without saying that KE Fibertec carries out extensive calculations for all specific installations using our proprietary 3D-dimensioning program WinVent. We therefore recommend allowing us to perform the final calculation so that calculations for pressure drop, air velocities and sound levels are performed on the basis of detailed models.

### DIMENSIONING: KE-LOW IMPULSE SYSTEM

The following input data is provided:

Room dimensions (L x W x H):	15 m x 10 m x 5.5 m
Bottom edge of duct:	4.8 m above floor level.
Heat distribution in room	Normal
Heat load in premises:	17400 W
Number of sockets and location:	3 sockets on the end wall
Inlet temperature and desired room temperature:	16°C / 20°C
Volume of air per socket:	4300 m <sup>3</sup> /h
Maximum air velocity in near zone:	0.20 m/s (room category B)
Total pressure available for textile ducts:	130 Pa

Room dimensions and layout



### CALCULATION PROCESS

The following calculation process is used:

1. Determine the maximum cooling load per metre of ducting.
2. Determine the required duct length.
3. Determine the number of low impulse ducts.
4. Determine the duct diameter.
5. Determine the type of textile material.
6. Check the air velocity at the entrance to the occupied zone.
7. Calculate the pressure loss.
8. Calculate the noise level.

## 1. MAXIMUM COOLING LOAD PER METRE OF DUCTING

Input parameters from datasheet 1 - diagram:  $\Delta T = 4^\circ\text{C}$  and room category B

Result:  $\Phi_m = 500 \text{ W/m}$

Input parameters from datasheet 1 - table:  $d = 3 \text{ m}$  and normal heat distribution

Correction,  $k$ , for duct location:  $k = 1.31$

$\Phi_{\text{max}} = \Phi_m \times k = 500 \text{ W/m} \times 1.31 = \underline{\underline{655 \text{ W/m}}}$

## 2. REQUIRED DUCT LENGTH

$17400 \text{ W} / 655 \text{ W/m} = \underline{\underline{27 \text{ m}}}$

## 3. NO. OF LOW IMPULSE DUCTS & SYSTEM LAYOUT

$27 \text{ m} / 10 \text{ m} = \underline{\underline{3 \text{ ducts at } L = 9 \text{ m}}}$

## 4. DUCT DIAMETER

Input parameters from datasheet 3:  $4300 \text{ m}^3/\text{h}$  and max. 7-8 m/s for inlet velocity

Duct diameter:  $D = \underline{\underline{\text{Ø}500 \text{ mm}}}$ ,  $v = 6 \text{ m/s}$

## 5. CHOICE OF TEXTILE MATERIAL

Input parameters from datasheet 6:

Surface area per duct:  $\pi \times D \times L = \pi \times 0.5 \text{ m} \times 9 \text{ m} = 14.1 \text{ m}^2$

Permeability:  $4300 \text{ m}^3/\text{h} / 14.1 \text{ m}^2 = 304 \text{ m}^3/\text{h}/\text{m}^2$

Choice of material: 025030,  $P_{s,\text{mid}} = 112 \text{ Pa}$

## 6. AIR VELOCITY CHECK

Maximum cooling load per metre of ducting:  $\Phi_{\text{max}} = 655 \text{ W/m}$

Actual cooling load per metre of ducting:

$$\Phi_{\text{Actual}} = Q_v \times \rho \times c_p \times \Delta T / L$$

$$\Phi_{\text{Actual}} = (4300 \text{ m}^3/\text{h} \times 1/3600 \text{ s/h} \times 1.205 \text{ kg/m}^3 \times 1007 \text{ J/(kg}\cdot^\circ\text{C)}) \times (20^\circ\text{C} - 16^\circ\text{C}) / 9 \text{ m}$$

$$\Phi_{\text{Actual}} = 644 \text{ W/m}$$

$$\underline{\underline{\Phi_{\text{Actual}} < \Phi_{\text{max}} \quad \text{OK!}}}$$

## 7. PRESSURE LOSS CALCULATION

$$P_{s,\text{mid}} = \underline{\underline{112 \text{ Pa}}}$$

$$P_{d,\text{mid}} = \frac{1}{2} \times \rho \times (v_{\text{mid}})^2 = \frac{1}{2} \times 1.205 \text{ kg/m}^3 \times (6 \text{ m/s})^2 = \underline{\underline{21.7 \text{ Pa}}}$$

$$P_{t,\text{mid}} = P_{s,\text{mid}} + P_{d,\text{mid}} = 112 \text{ Pa} + 21.7 \text{ Pa} = \underline{\underline{133.7 \text{ Pa}}}$$

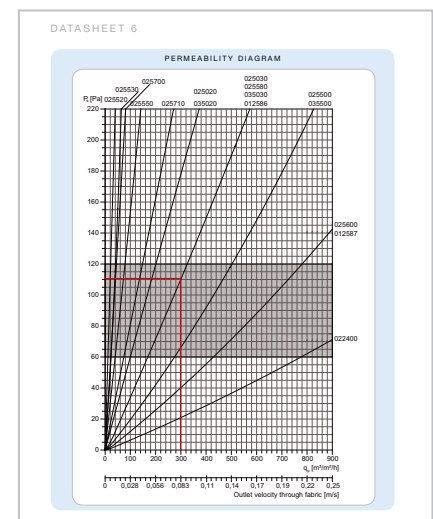
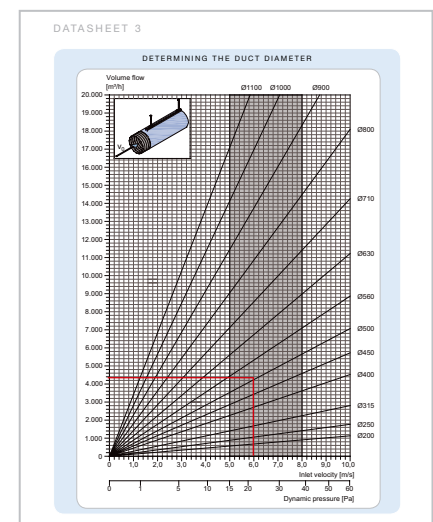
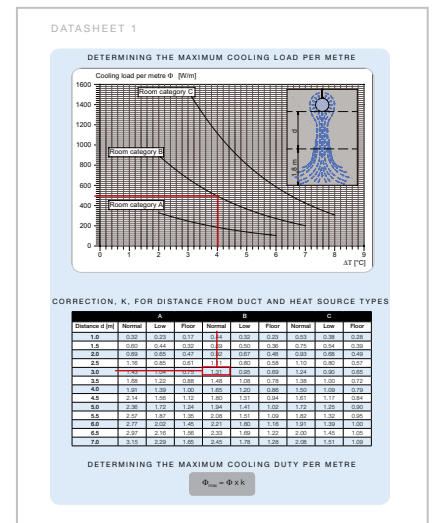
$$P_{t,\text{start}} = 118 \text{ Pa} \text{ (friction loss} = 0 \text{ Pa)}$$

$$P_{s,\text{start}} = P_{t,\text{start}} - P_{d,\text{start}} = 118 \text{ Pa} - \frac{1}{2} \times \rho \times (6 \text{ m/s})^2 = 96 \text{ Pa} \text{ (ESP)}$$

$$\underline{\underline{P_{t,\text{start}} = 118 \text{ Pa} < 130 \text{ Pa} \quad \text{OK!}}}$$

## 8. NOISE CALCULATION

See the calculation in chapter 12.

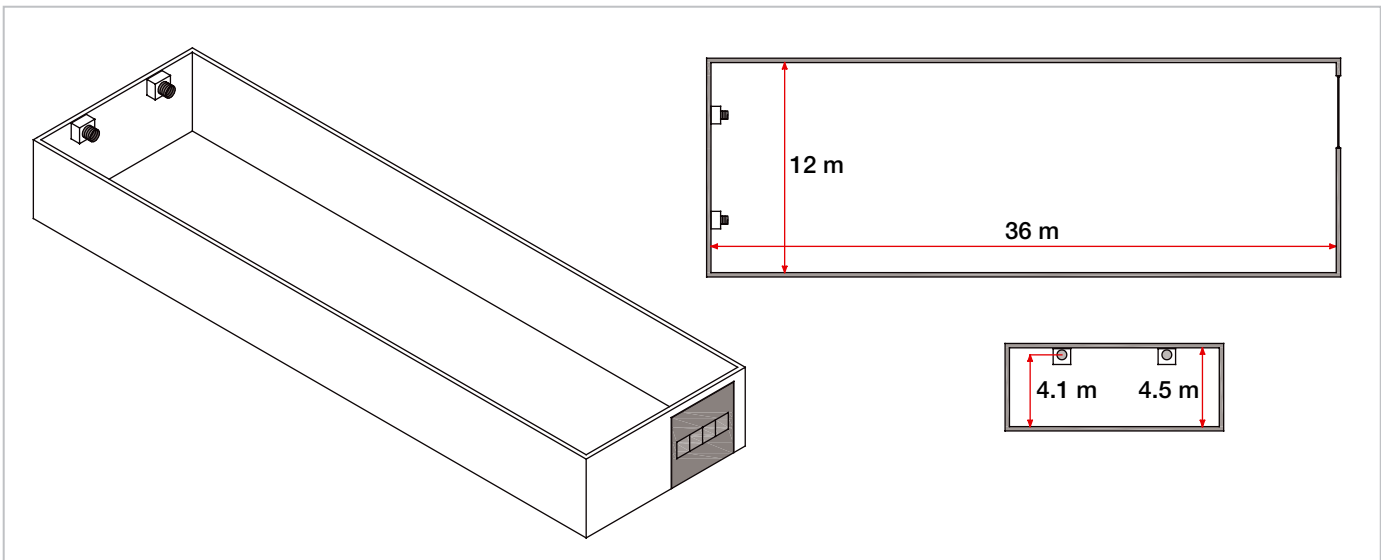


## DIMENSIONING: KE-INJECT SYSTEM

The following input data is provided:

Room dimensions (L x W x H):	36 m x 12 m x 4.5 m
Centre of duct:	4.1 m above floor level
Number of sockets and location:	2 sockets on the end wall
Inlet temperature and desired room temperature:	21°C / 21°C (isothermal)
Volume of air per socket:	6000 m <sup>3</sup> /h
Choice of material:	026500 (impermeable)
Wall jet required:	ST-1 (wall jet)
Maximum air velocity in near zone:	0.20 m/s (room category B)
Total pressure available for textile ducts:	120 Pa

Room dimensions and layout



## CALCULATION PROCESS

The following calculation process is used:

1. Determine the number and length of KE-Inject ducts.
2. Determine the duct diameter.
3. Determine the volume flow per running metre of ducting.
4. Determine the hole design.
5. Determine the number of hole rows, the static pressure and throw length.
6. Determine the air velocity at the entrance to the occupied zone.
7. Calculate the pressure loss.
8. Calculate the noise level.

## 1. NUMBER AND LENGTH OF DUCTS

2 sockets = 2 ducts

Room length: 36 m - Duct length 35 m

## 2. DUCT DIAMETER

Input parameters from datasheet 3: 6000 m<sup>3</sup>/h and max. 7-8 m/s for inlet velocity

Duct diameter: D = Ø560 mm, v = 6.8 m/s

## 3. VOLUME FLOW PER RUNNING METRE OF DUCTING

6000 m<sup>3</sup>/h / 35 m = 171 m<sup>3</sup>/h/m

## 4. HOLE DESIGN

LV hole design chosen due to room category B (see p. 83)

## 5. HOLE ROWS, STATIC PRESSURE & THROW LENGTH

Input parameters from datasheet 8: 171 m<sup>3</sup>/h/m

Number of hole rows per side: 8

Static pressure: 105 Pa

Min. throw length  $l_{0,20} = 3.8$  m

## 6. AIR VELOCITY AT ENTRANCE TO OCCUPIED ZONE

Current throw length in room: 12 m/4 + (4.1 m - 1.8 m) = 5.3 m

Isothermal air velocity after 5.3 m:  $v_{iso} = (3.8 \text{ m} / 5.3 \text{ m}) \times 0.20 \text{ m/s} = \underline{0.14 \text{ m/s}}$

Flow model 1 (wall jet):  $v_{iso} = \sqrt{2} \times 0.14 \text{ m/s} = \underline{0.20 \text{ m/s}}$

## 7. PRESSURE LOSS CALCULATION

$P_{s,mid} = 105 \text{ Pa}$

$P_{d,mid} = \frac{1}{2} \times \rho \times (v_{mid})^2 = \frac{1}{2} \times 1.205 \text{ kg/m}^3 \times (\frac{1}{2} \times 6.8 \text{ m/s})^2 = \underline{7 \text{ Pa}}$

$P_{t,mid} = P_{s,mid} + P_{d,mid} = 105 \text{ Pa} + 7 \text{ Pa} = \underline{112 \text{ Pa}}$

$P_{t,start} = 112 \text{ Pa}$  (friction loss = 0 Pa)

$P_{s,start} = P_{t,start} - P_{d,start} = 112 \text{ Pa} - \frac{1}{2} \times \rho \times (6.8 \text{ m/s})^2 = 85 \text{ Pa}$  (ESP)

$P_{t,start} = 112 \text{ Pa} < 120 \text{ Pa}$  OK!

## 8. NOISE CALCULATION

Input parameters from datasheet 18:  $P_{t,start} = 112 \text{ Pa}$ , basic sound power level:  $\approx \underline{43 \text{ dB(A)}}$

Correction for length of duct and number of hole rows:

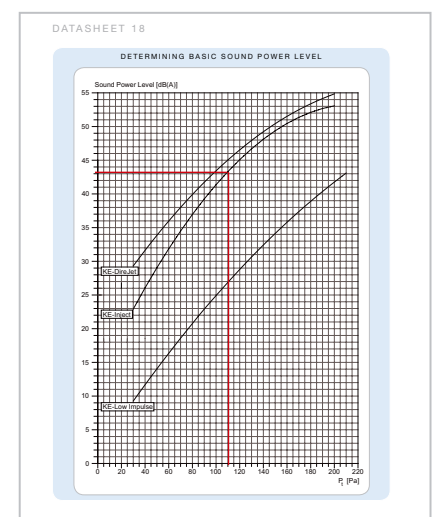
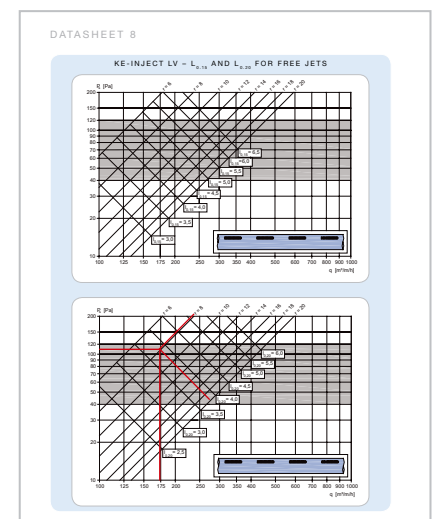
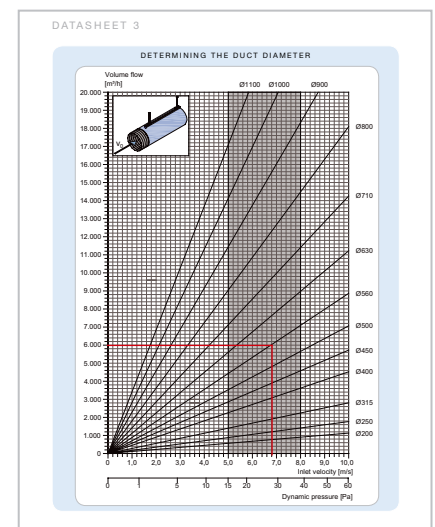
Input parameters from datasheet 19: number of hole rows in total = 16, L = 17.5 m

Correction: + 7.5 dB(A) + 3 dB(A)\* = 10.5 dB(A)

Resulting sound power level per duct: 43 dB(A) + 10.5 dB(A) = 53.5 dB(A)

Resulting sound power level transmitted to room: 53.5 dB(A) + 3 dB(A)\* = 56.5 dB(A)

\*3 dB(A) is added for the sound power level every time the number of ducts double.

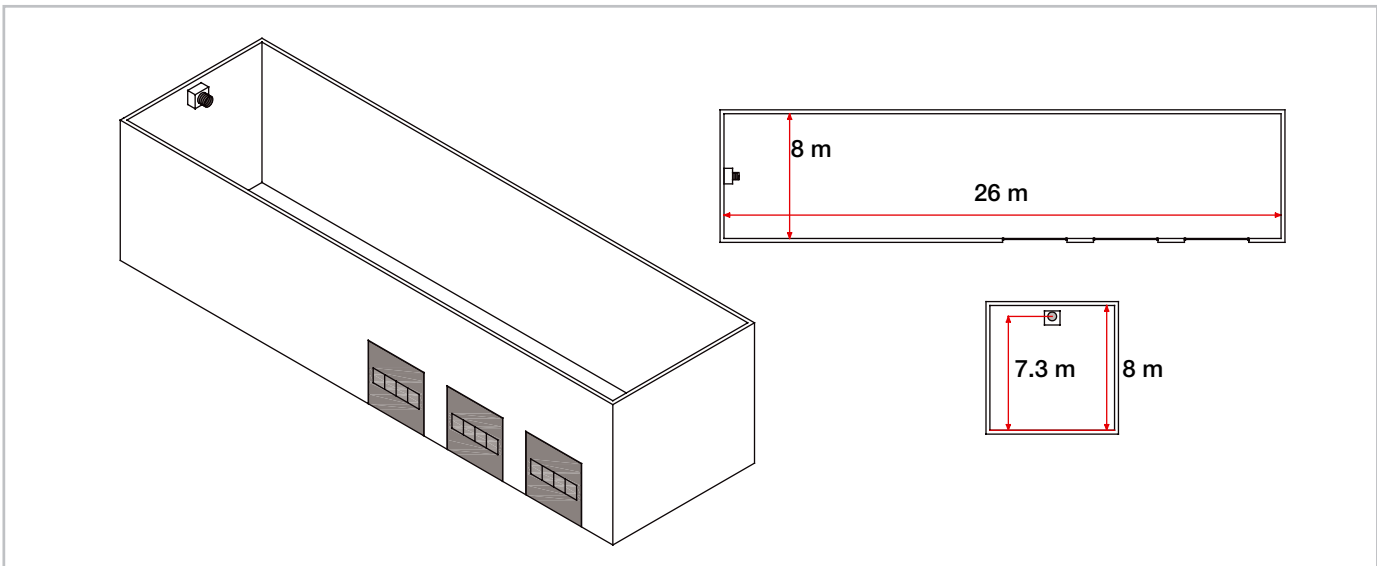


## DIMENSIONING: KE-DIREJET SYSTEM

The following input data is provided:

Room dimensions (L x W x H):	26 m x 8 m x 8 m
Centre of duct:	7.3 m above floor level
Number of sockets and location:	1 socket on the end wall
Inlet temperature and desired room temperature:	4°C / 4°C (isothermal)
Volume flow per socket:	5300 m <sup>3</sup> /h
Choice of material:	026500 (impermeable)
Free jet required:	ST-3 (free jet)
Maximum air velocity in near zone:	0.30 m/s
Total pressure available for textile ducts:	140 Pa

Room dimensions and layout



## CALCULATION PROCESS

The following calculation process is used:

1. Determine the number and length of KE-DireJet ducts.
2. Determine the duct diameter.
3. Determine the volume flow per running metre of ducting.
4. Determine the nozzle type.
5. Determine the number of nozzles per metre, the static pressure and throw length.
6. Determine the air velocity at the entrance to the occupied zone.
7. Calculate the pressure loss.
8. Calculate the noise level.

## 1. NUMBER AND LENGTH OF DUCTS

1 socket = 1 duct

Room length: 26 m - Duct length 25 m

## 2. DUCT DIAMETER

Input parameters from datasheet 3: 5300 m<sup>3</sup>/h and max. 7-8 m/s for inlet velocity

Duct diameter: D = Ø560 mm, v = 6 m/s

## 3. VOLUME FLOW PER RUNNING METRE OF DUCTING

5300 m<sup>3</sup>/h / 25 m = 212 m<sup>3</sup>/h/m

## 4. CHOICE OF NOZZLE

A Ø18 mm nozzle is selected.

## 5. NO. NOZZLES, STATIC PRESSURE & THROW LENGTH

Input parameters from datasheet 13: 212 m<sup>3</sup>/h/m

Number of nozzles per side: 10

Static pressure: 121 Pa

Min. throw length  $l_{0,30}$  = 6.0 m

## 6. AIR VELOCITY AT ENTRANCE TO OCCUPIED ZONE

Current throw length in room: 6.0 m (150° downward slant)

Isothermal air velocity after 6.0 m:  $v_{iso}$  = 0.30 m/s

## 7. PRESSURE LOSS CALCULATION

$P_{s,mid}$  = 121 Pa

$P_{d,mid}$  =  $\frac{1}{2} \times \rho \times (v_{mid})^2 = \frac{1}{2} \times 1.205 \text{ kg/m}^3 \times (1/2 \times 6 \text{ m/s})^2 = \underline{6 \text{ Pa}}$

$P_{t,mid}$  =  $P_{s,mid} + P_{d,mid} = 121 \text{ Pa} + 6 \text{ Pa} = \underline{127 \text{ Pa}}$

$P_{t,start}$  = 127 Pa (friction loss = 0 Pa)

$P_{s,start}$  =  $P_{t,start} - P_{d,start} = 127 \text{ Pa} - \frac{1}{2} \times \rho \times (6 \text{ m/s})^2 = 106 \text{ Pa}$  (ESP)

$P_{t,start}$  = 127 Pa < 140 Pa OK!

## 8. NOISE CALCULATION

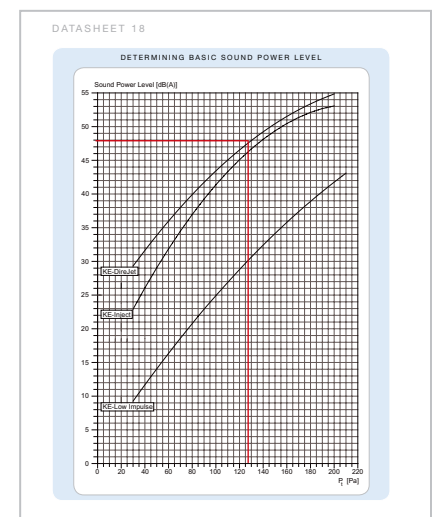
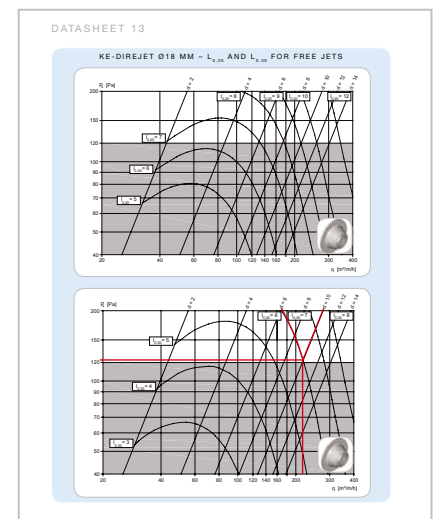
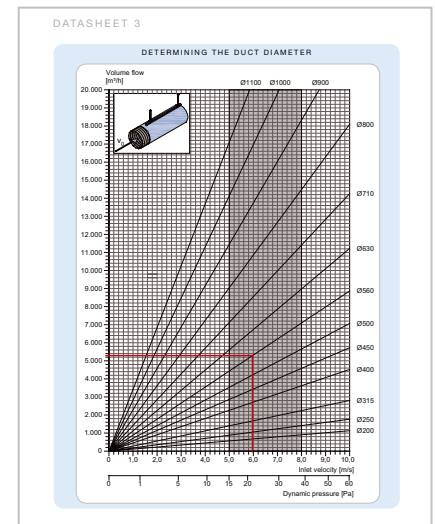
Input parameters from datasheet 18:  $P_{t,start}$  = 127 Pa, basic sound power level: = 48 dB(A)

Correction for length of duct and number of nozzles:

Input parameters from datasheet 20: number of nozzles per metre in total = 20, L = 25 m

Correction: + 7 dB(A)

Resulting sound power level transmitted to room: 48 dB(A) + 7 dB(A) = 55 dB(A)





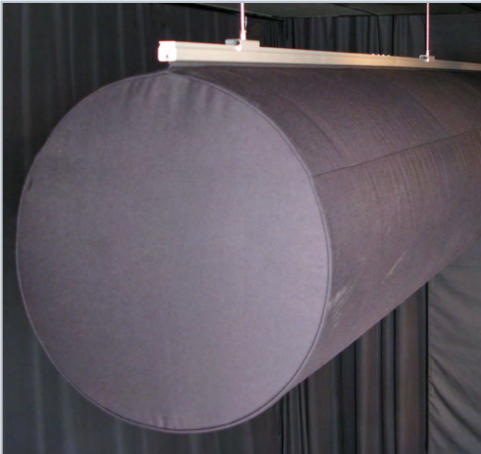
## 15. SUSPENSION SYSTEMS



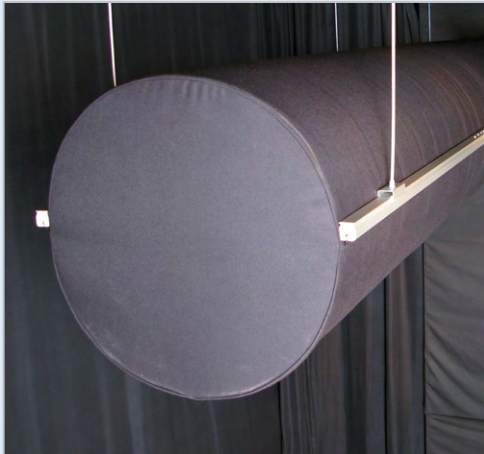
# SUSPENSION SYSTEMS



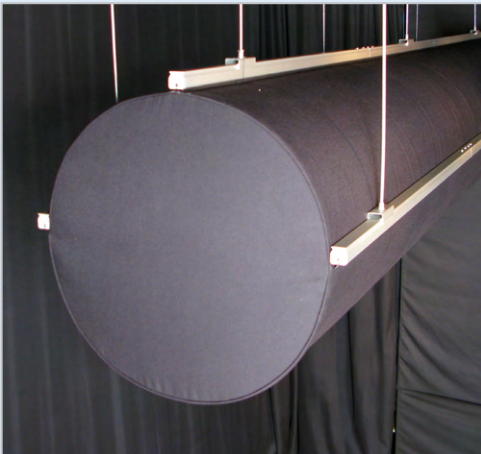
KE Fibertec's TBV systems can be supplied with different suspension systems which can be fitted to any type of ceiling. What all the suspension systems have in common is that they are supplied cut to the same length as the textile duct. They are also packaged with the necessary fixing components and a specific label indicating where they are meant to be installed. See also the installation instructions and other information at [ke-fibertec.com](http://ke-fibertec.com).



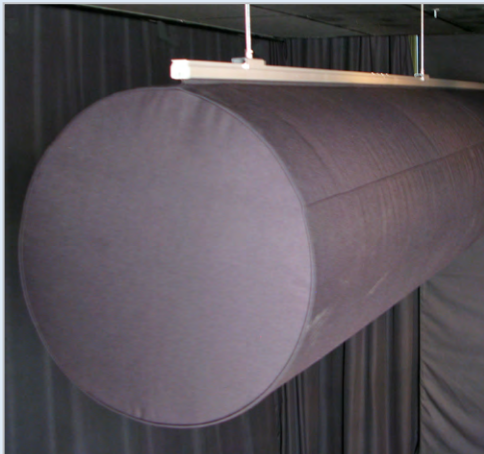
**SINGLE ROW SUSPENSION SAFETRACK**



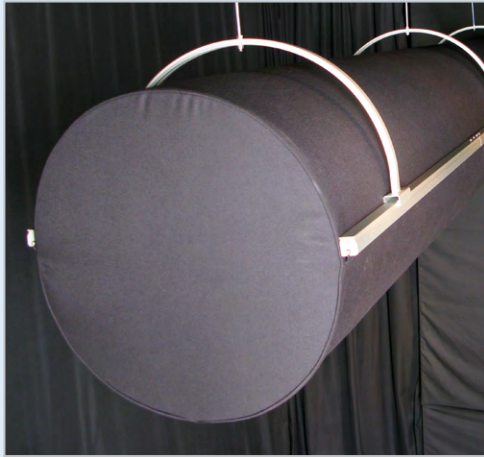
**DOUBLE ROW SUSPENSION SAFETRACK**



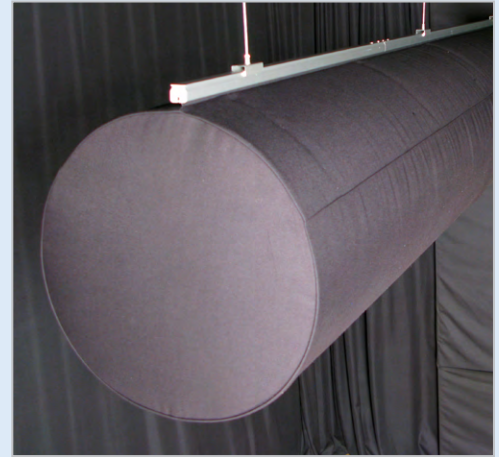
**TRIPLE ROW SUSPENSION SAFETRACK**



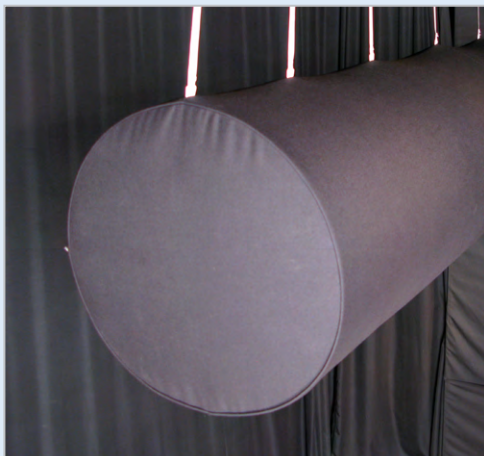
**SINGLE ROW SUSPENSION SAFETRACK DUCT ARCH**



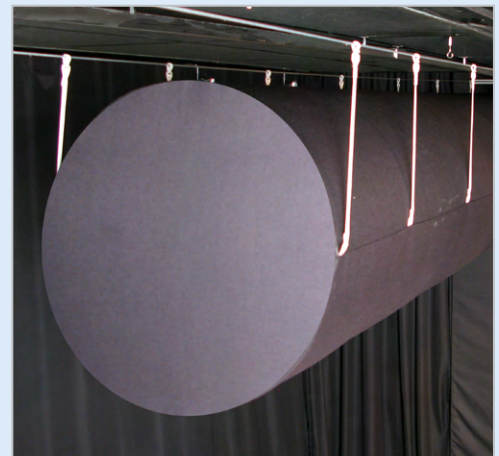
DOUBLE ROW SUSPENSION  
SAFETRACK DUAL ARCH



SINGLE ROW SUSPENSION  
SAFETRACK 360°



SINGLE ROW SUSPENSION  
WIRE



DOUBLE ROW SUSPENSION  
WIRE



D-LITE ALU



D-ALU

# SUSPENSION SYSTEMS



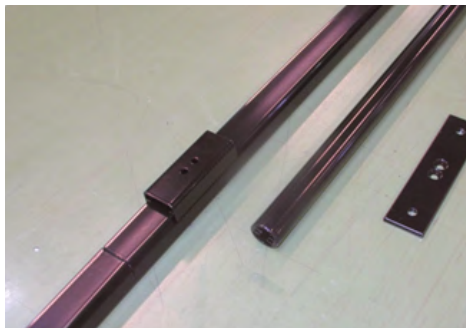
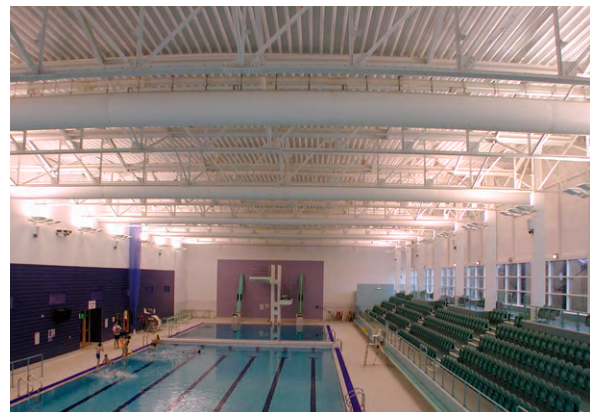
## CURVED TEXTILE DUCTS

Product development of the TBV design now enables us to offer curved textile ducts designed for a specific radius and with Safetrack rails that conform to the shape of the duct. This product can naturally be combined with both ordinary passive low impulse systems and with our hybrid solution in which the low impulse system is made with lasercut inject holes.

A good example is below system that KE Fibertec supplied to Algida Unilever's main office in Istanbul.

## MOUNT EASY

For systems with difficult access, for instance in swimming pool areas where the TBV systems are suspended above the pool KE Fibertec offers a solution with cord pull called Mount Easy. The Mount Easy system enables a single person to install textile ducts of up to 40 metres from one end.

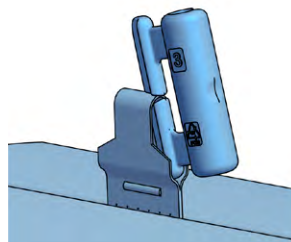


## COLOURED RAILS

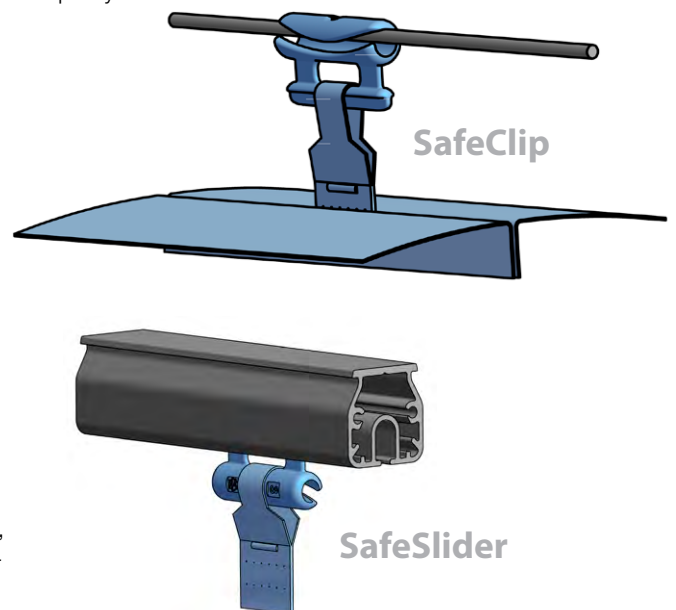
Specific types of suspension systems are now also available in any given colour. All visible parts are powder coated and offer a high impact-resistant quality.

## SAFESLIDER - COMBI SOLUTION FOR RAILS AND WIRE

Combination of clip (SafeClip) and slider (SafeSlider) in one and the same stable solution. The SafeSlider can be turned if you want to change from rail to wire or vice versa.



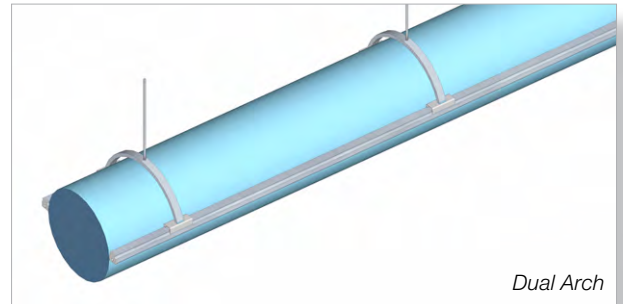
The flexible product fits other types of rails and other brands, and is available in melon yellow, traffic red, light blue, black, white, ultramarine blue, green or light grey.



## SAFETRACK ARCHES

### DUAL ARCH

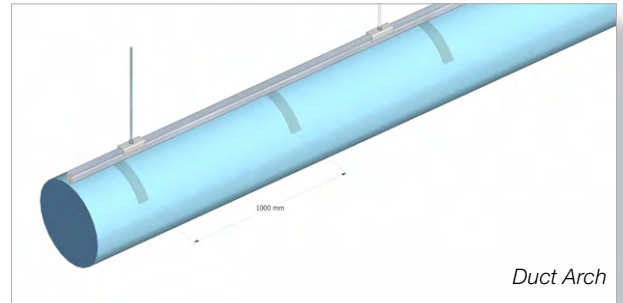
Dual Arch mounting brackets utilize the stability of double rails and at the same time they are quick and easy to install. Large textile ducts will be stably suspended both with and without air and installation time is reduced considerably as the ducts are mounted in a single ceiling rail. Scan the QR code to watch the YouTube Dual Arch video.



Dual Arch

### DUCT ARCH

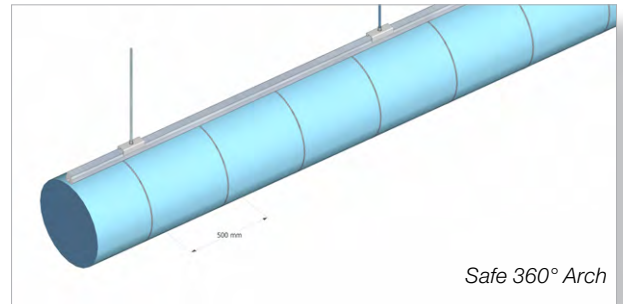
Duct Arch is a pre-bent aluminium rail mounted in hidden sewn-in pockets in the TBV ducts. The Arches reduce sagging when the air is off and prevent popping with ON-OFF start. The unique Safetrack is designed in a way so that the Arch brackets are easily clicked onto the ceiling rail without any tools.



Duct Arch

### SAFE 360° ARCH

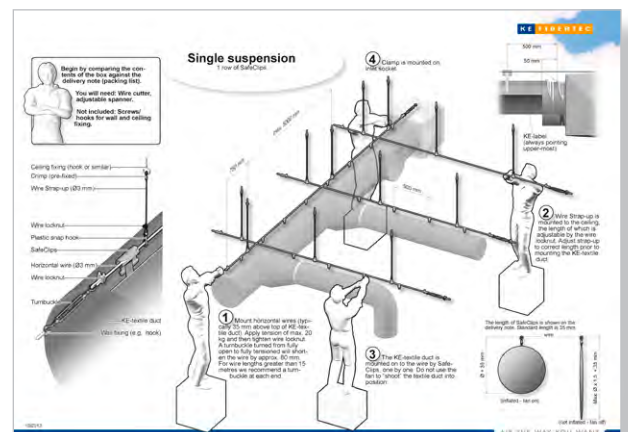
The Safe 360° system consists of removable rings per 1000 mm or 500 mm. The stainless steel rings are locked with velcro (12, 3, 6 and 9 o'clock) inside the ducts so that they can easily be removed for washing. The ducts will keep looking inflated, and it is our best solution if popping is a big problem.

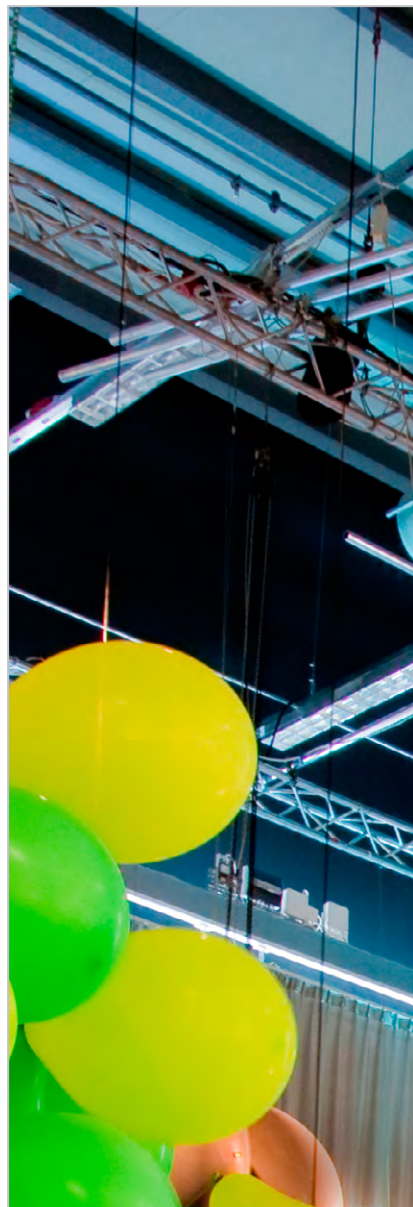


Safe 360° Arch

## SEE ALSO...

...KE Fibertec's separate instructions and installation tips for the various suspension systems. This material will provide you with a brief description of each type of suspension, along with useful information about subcomponents for assembly etc.





## 16. WASHING AND MAINTENANCE



## GOOD INDOOR CLIMATE FOR EVERYONE'S BENEFIT

Buildings are ventilated in order to create a satisfactory indoor climate and guarantee a healthy working environment. It is therefore crucial that the buildings we occupy have a good indoor climate. Poor air quality affects our ability to work as it can make it difficult for us to concentrate and irritate our eyes and nose. A poor indoor climate can therefore increase the level of absence through sickness, which has major financial consequences both for the individual company and for society as a whole.

## DIRTY DUCTS AND POLLUTED AIR

The indoor climate and the air that people breathe are affected and polluted by many different sources, including gases given off from building materials, machines, furniture and people. But the air is not only affected by internal sources in the room, but also largely by external pollution. External sources of pollution very often originate from the outdoor environment or from dirty ventilation systems.

Internal pollution must be limited at the source. This can be done as much as possible using local extraction vents and limiting the presence of polluting machines and furniture. External sources of pollution can be limited by effectively pre-filtering the ventilation air, as well as by cleaning and servicing the ventilation system.

A ventilation system which has been wrongly dimensioned or one which has run without pre-filtering due to an error or whose filters are worn will contribute significantly to polluting the internal environment. The ventilation ducts will become dirty over time and dust will be deposited in ducts, on dampers and valves. Dust, dirt and, in the worst case scenario, micro-organisms in the ventilation system will reduce the ventilation's impact and may, in some cases, be directly harmful to people's health. To ensure a healthy indoor climate and the best possible energy savings, it is therefore important to regularly inspect ducts, dampers, valves and filters in the ventilation system, no matter what types of ventilation system and air distribution system are being used.

In the case of systems with steel ducts, maintenance is often the major issue and studies have shown that a poorly maintained ventilation system is one of the main reasons for a poor indoor climate. To ensure that a textile based low impulse system can operate as it is intended to, the system must be washed and maintained. KE Fibertec's textile based ventilation systems can simply be removed and washed.

There are different reasons for washing and maintaining low impulse ducts. For example, there may be hygienic reasons as in the food industry where production must be carried out in microbiological pollution-free conditions. It may also be required due to the fact that the ducts have acquired an undesirable grey colour as a result of dust particles becoming ingrained in the textile fibres or that the systems have become clogged up due to internal dirt. This dirt can be caused, for instance, by soot, dust particles, grease or oil particles from outdoor air or by the recirculated air.

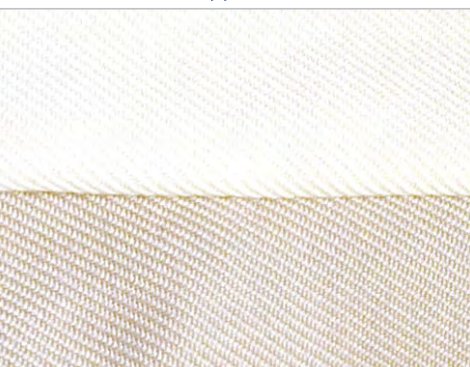
## PRE-FILTRATION

Textile ducts operate like a filter, absorbing impurities as small as 0.5 µm inside the fabric, thereby ensuring that fresh, filtered air is always distributed throughout the premises. To avoid unnecessary washing, textile ducts should not be the only filter present. Using a pre-filter of at least Class F7 for all outdoor air is always recommended. The next table shows to what extent pre-filters with different dirt-removing capabilities can reduce the need to wash textile ducts.



” A clean ventilation duct and a duct with deposits of dust and dirt. ”

” The grey colour is due to dust particles becoming ingrained in the textile fibres or the system getting clogged up due to internal dirt. ”



As shown in the table, the washing frequency can be reduced considerably by improving the pre-filtering and changing, for instance, from an F5 to an F7 or F9 filter. The requirements for the fan's performance are also increased, which means that the extra performance must already be factored in at the design phase as there will be no opportunity later on to build in an effective pre-filter without the calculated volume flow falling dramatically.

Class	Dirt-removing capability [%]	Relative reduction in washing frequency (approx.)	Pressure drop above filter (approx.) [Pa]
G3	25	1.2	90
F5	45	1.8	120
F7	85	7.0	200
F9	>95	20	250

## WASHING INTERVALS

The intervals for washing and maintaining KE Fibertec's low impulse systems naturally depend on what kind of premises they are being used in, and we recommend different washing intervals according to use. The table below shows the recommended washing intervals specified for different uses of KE Fibertec's low impulse systems. It should be noted that this table is simply for guidance.



Application	Outdoor air [%]	Pre-filter class	Approx. no. washes per year
Moulded cheese production etc. The textile ducts are washed when production has stopped to protect against any undesirable micro-organisms.	10	F7	6-20
Polluted premises with severe microbiological pollution, e.g. quick chopping room for the processing of spices. The textile ducts can be washed to remove organic material stored inside the ducts.	10	F7	3-4
Premises with particular hygiene requirements, e.g. where unpacked meat products are processed.	10	F7	1-2
Premises where there are no particular hygiene requirements, e.g. store rooms for packaged products.	10	F7	0.3-1
	100	F7	0.5-1
	100	F5	1-4
Offices	100	F9	0.2-1
	100	F7	0.5-1
	100	F5	1-4

## MAINTENANCE OF LOW IMPULSE SYSTEMS/HYBRID HIGH IMPULSE SYSTEMS

KE Fibertec's Low Impulse and Interior systems can have a long service life if used properly. These products have been developed so that they can be washed and serviced up to 100 times without their permeability differing from that of a new product. The following precautions must be observed to achieve the longest possible service life. Please note that the same instructions apply to the washing and maintenance of the hybrid high impulse systems:

- The systems must hang freely so that the textile material does not rub against fixed objects, thereby causing damage.
- The systems must hang still as pulsations can damage the textile material. Violent jolts must also be avoided when starting up the system as this can cause the suspension system or textile duct to come loose or sustain serious damage.
- The systems must be protected when being installed and removed so that the textile materials are not damaged.
- Outdoor air passing through the systems must be pre-filtered – Class F7 – to avoid them quickly becoming clogged up.
- The systems must be washed, centrifuged and dried according to KE Fibertec's instructions to prevent them from getting damaged.



” Textile ducts can be washed in an ordinary washing machine, but often industrial washing machines are used because of their larger capacity.”

## WASHING PROCEDURE

To protect the textiles, it is recommended that you only fill the machines with around half the volume used for an economy wash. This also applies if the systems are dried in a tumble-dryer. Drip drying is recommended, but the material can be dried in a tumble-dryer, provided the material temperature never exceeds 60°C and the drying air temperature never exceeds 80°C. After drying the material must be ventilated with cold air until the tumbler is cold. When centrifuging the material you are recommended to select a speed which leaves around 50% of the water behind in the systems. The following procedure must be observed when washing low impulse systems:

1. Wash 1-4 times at 20-40°C using a detergent. (Add the amount of detergent specified on the packet.) Each wash cycle should last around 15 minutes. The washing process should be repeated until the wash water is completely clean.
2. In the case of heavily soiled textile ducts, rinsing is recommended between each wash in just plain water.
3. Rinse with clean water.
4. Rinse with a disinfectant (chlorinated product min. 200 mg/l active chlorine).
5. Rinse with clean water containing an anti-chlorine product (sodium thiosulphate, 1 g per kg dry textile material).
6. Rinse with clean water.
7. Drip dry - centrifuge or hang up damp.

## SHRINKAGE AND DAMAGE DURING MAINTENANCE

KE Fibertec's KE-Low Impulse/KE-Interior systems have been developed so that they can be serviced without the materials shrinking, thereby creating problems. However, if shrinkage does occur significantly above 1%, this is due to the following:

- Temperature was too high during washing. If the textile materials are washed at too high temperatures they will shrink by up to 5% or more.
- Temperature was too high during drying. If the temperature is too high during drying shrinkage can exceed 3%.

Consequently, in order to achieve the maximum service life for the textile systems, it is absolutely crucial that the maximum washing and drying temperatures are observed. Other types of damage which may occur during washing and maintenance are:

- Pilling (formation of small, fuzzy balls on the textile surface).
- The textile material becomes worn and the clips etc. become damaged etc.

Pilling occurs when the materials rub against each other during washing and especially when being dried in a tumble-dryer. KE Fibertec's low impulse materials have been enhanced so that the tendency to pilling is only about half the normal rate for equivalent textiles. This means that the systems can be washed a number of times without looking "overwashed". If drying in a tumble-dryer can be avoided this will considerably extend the period during which the systems look as good as new. Washing and drying wear out the textile material, so excessive time spent washing and drying it in a tumble-dryer should be avoided. Damage often occurs to tabs and similar items if the machines are overloaded. It is therefore recommended to avoid filling the machine up too much.



” All KE Fibertec's products have a label indicating the recommended washing and aftercare instructions. The symbols used on the label comply with the recommendations in Danish standard DS 2128 Textile goods – Cleaning labelling.”



## CLEAN ROOM MATERIALS

KE Fibertec's clean room materials are specially developed for distributing micro-filtered air. The materials are white as standard. If they are dyed or washed there is no guarantee that they cannot add particles to the surrounding environment afterwards. If the pre-filters are maintained properly there is no reason to maintain KE Fibertec's clean room quality materials. They will go on working for years and can then be changed for new ones. KE Fibertec's clean room materials will not shed particles to the surrounding environment if a properly functioning H 12 pre-filter is used in a Class 10000 clean room.

## MAINTENANCE OF HIGH IMPULSE SYSTEMS

There is a fundamental difference in the maintenance of a textile based low impulse system and a textile based high impulse system manufactured using a coated polyester material. The high impulse system obviously has no filtering effect, which means that high impulse systems are not especially sensitive to dust particles either as the material does not get clogged up. The air distributed in the room passes right through the holes/nozzles and any internal dirt in the ducts is often largely limited to heavy particles, which often occurs when there is no pre-filter in place.

If there is no pre-filter, dust particles will also be deposited around the holes where the air flows out. This will produce external dirt, which is visible and unsightly if the holes are visible. These deposits will occasionally break loose and be carried with the air out into the space in lumps, which may pollute the surrounding environment. High impulse systems also draw in a huge amount of room air, which becomes mixed with the air delivered through the holes.

If there is a high level of dust particles in the air which then come into contact with the system's surface, dust particles may be deposited, which can then become visible on the surface afterwards. KE Fibertec therefore also recommends using a Class 7 pre-filter, even with a recirculation system. The fewer dust particles there are in both the inside and outside air, the less dirt there will be and the less maintenance will be required.

## PROCEDURE FOR EXTERNAL CLEANING

KE Fibertec's high impulse systems have been manufactured using polyester fabric with an external synthetic coating. This coating has a dirt-repellent finish, making it easy to clean and service. Every type of cleaning agent that can normally be used for floors, tables, walls etc. may be used to clean the systems externally. The systems can be washed and dried externally using a cloth, brush, sponge etc. Care should be taken not to expose the systems to tugging and overstretching during cleaning. Loose external dust particles can also be removed using a vacuum cleaner or by blowing them away with air.

## PROCEDURE FOR INTERNAL CLEANING

If required, dirt which has accumulated internally can be removed by reversing the coated material and vacuuming the dirt away. The internal side can then be washed in the same way as the external side.

High impulse systems may get so dirty that it is preferable to wash them in a washing machine. If this happens, a programme for washing delicates is recommended, which means a prewash at 30°C followed by drip drying. Machines must only be filled to around 1/3 of their normal capacity. Only washing machines which have a low mechanical impact on the systems should be used.



” Example of an external deposit of dust particles. ”



” KE Fibertec's high impulse systems are usually cleaned when required, but the systems and pre-filter should be inspected at least once a year. ”



## 17. INTEX®



A HEALTHY INDOOR CLIMATE AND ENERGY EFFICIENCY  
WITH TEXTILE DUCT SENSORS



**INTEX® - INTELLIGENT TEXTILE DUCTS**

Be notified when the textile duct needs cleaning. This is the idea of InTex® which monitors the air pressure of your textile based ventilation system. InTex® will result in a healthy indoor climate and energy savings that will benefit both the environment and the operating economy of the plant.

All ventilation ducts, steel or textile, must be cleaned regularly in order to stay efficient. The InTex® sensor makes it easy to keep the textile ducts operational to ensure that they always provide draught-free air distribution and a good indoor climate. Textile ducts are easily taken down for washing in a regular washing-machine.



**InText®  
sensor**

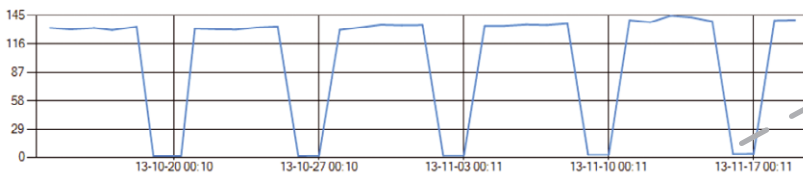


**InText®  
master**

## HOW IT WORKS

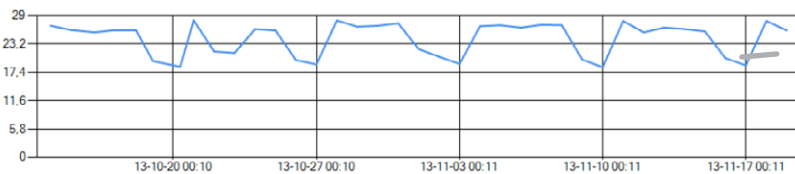
The sensor is installed at the end section of the textile duct and will constantly communicate with the master device located elsewhere in the building. When the static pressure reaches a specific level, it will automatically generate an e-mail and you will be able to log onto the InText® webpage.

Below charts show which sensors have recorded a change of pressure that indicates which textile ducts need washing.



### Pressure

The pressure in the textile duct drops when the ventilation system is turned off at night. Night-time reduction helps save energy.



### Temperature

The temperature rises when the room heating is turned on in the morning.



[ke-fibertec.com/intex](http://ke-fibertec.com/intex)

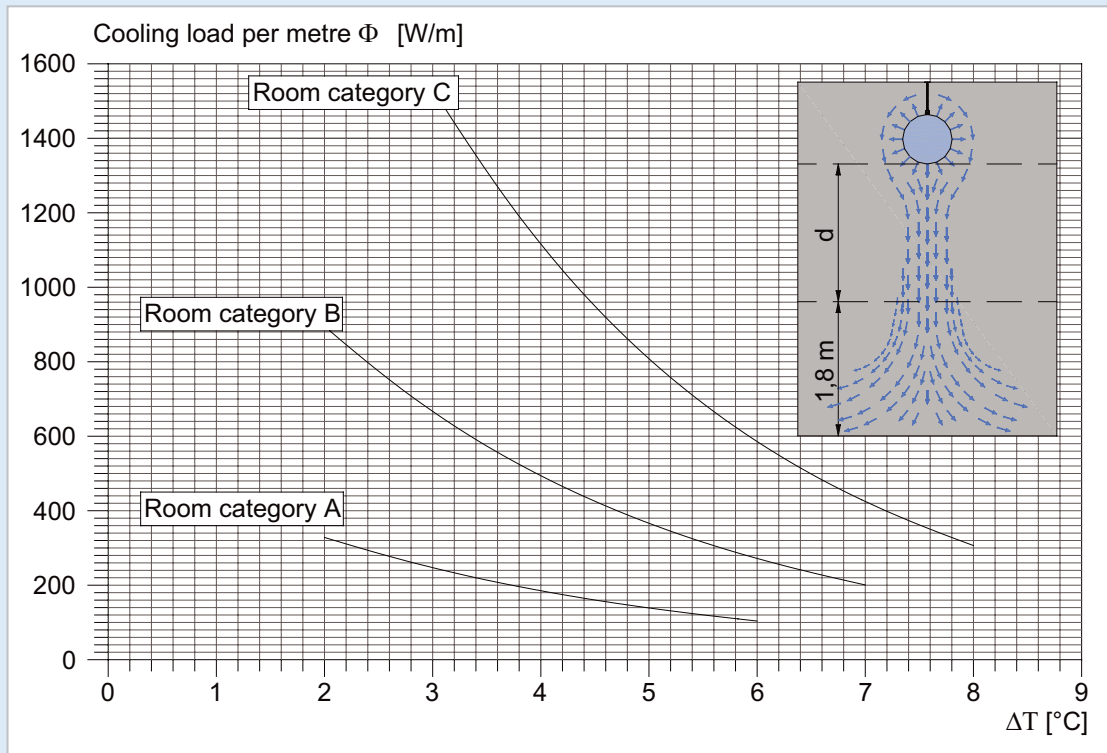


## 18. DATASHEETS



## DATASHEET 1

### DETERMINING THE MAXIMUM COOLING LOAD PER METRE



### CORRECTION, K, FOR DISTANCE FROM DUCT AND HEAT SOURCE TYPES

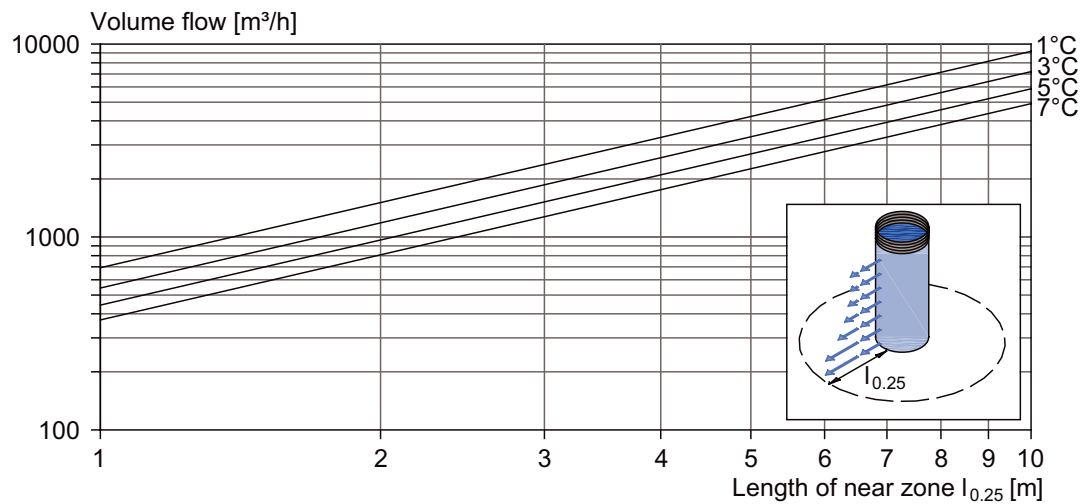
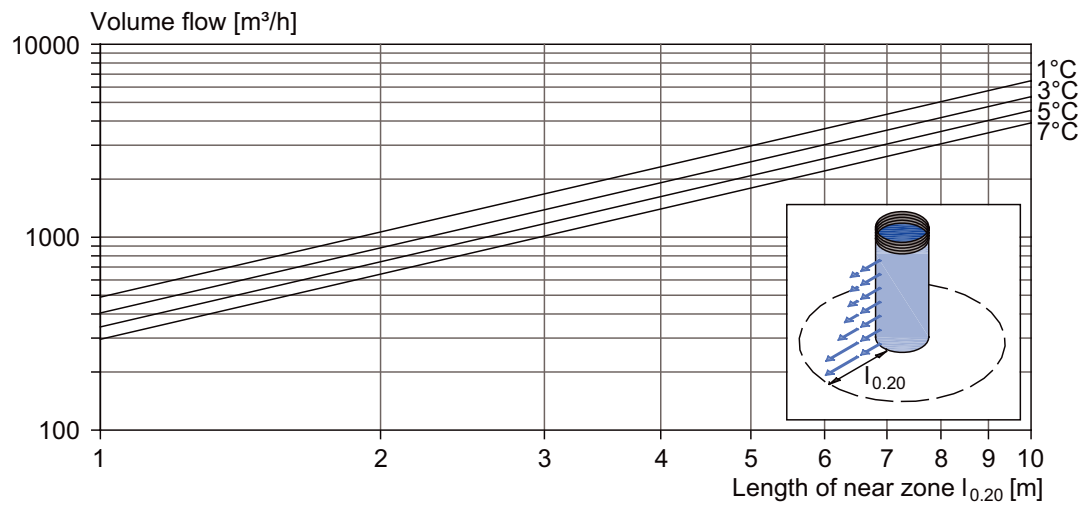
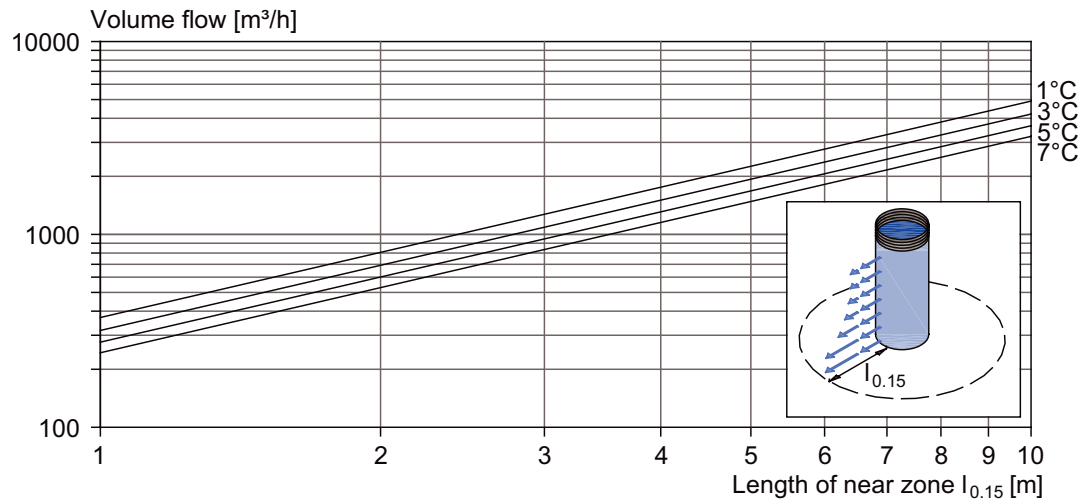
Distance d [m]	A			B			C		
	Normal	Low	Floor	Normal	Low	Floor	Normal	Low	Floor
1.0	0.32	0.23	0.17	0.44	0.32	0.23	0.53	0.38	0.28
1.5	0.60	0.44	0.32	0.69	0.50	0.36	0.75	0.54	0.39
2.0	0.89	0.65	0.47	0.92	0.67	0.48	0.93	0.68	0.49
2.5	1.16	0.85	0.61	1.11	0.80	0.58	1.10	0.80	0.57
3.0	1.43	1.04	0.75	1.31	0.95	0.69	1.24	0.90	0.65
3.5	1.68	1.22	0.88	1.48	1.08	0.78	1.38	1.00	0.72
4.0	1.91	1.39	1.00	1.65	1.20	0.86	1.50	1.09	0.79
4.5	2.14	1.56	1.12	1.80	1.31	0.94	1.61	1.17	0.84
5.0	2.36	1.72	1.24	1.94	1.41	1.02	1.72	1.25	0.90
5.5	2.57	1.87	1.35	2.08	1.51	1.09	1.82	1.32	0.95
6.0	2.77	2.02	1.45	2.21	1.60	1.16	1.91	1.39	1.00
6.5	2.97	2.16	1.56	2.33	1.69	1.22	2.00	1.45	1.05
7.0	3.15	2.29	1.65	2.45	1.78	1.28	2.08	1.51	1.09

### DETERMINING THE MAXIMUM COOLING LOAD PER METRE

$$\Phi_{\max} = \Phi_m \times K$$

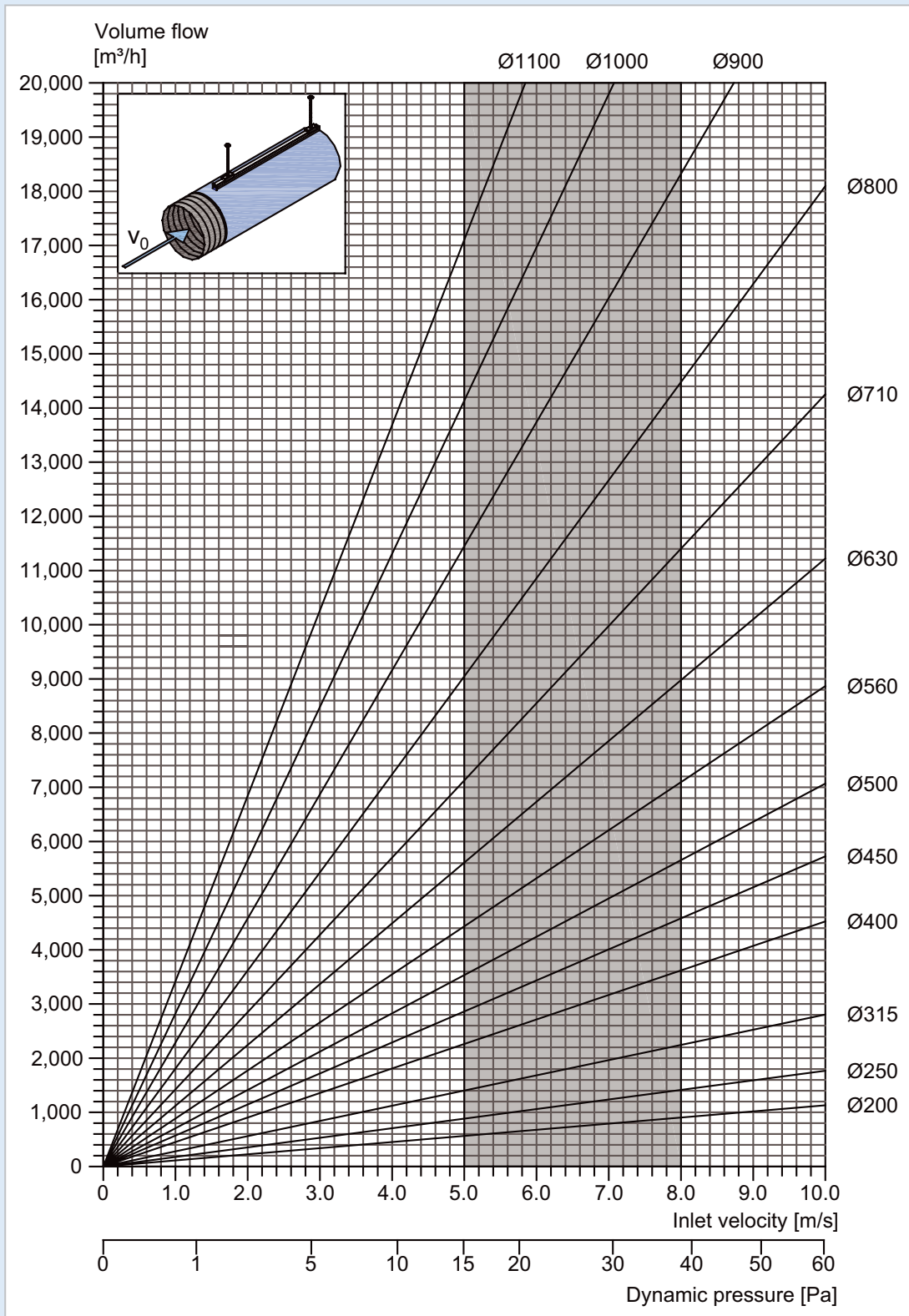
# DATASHEET 2

## DETERMINING LENGTH OF NEAR ZONE, $L_{0.15}$ , $L_{0.20}$ AND $L_{0.25}$



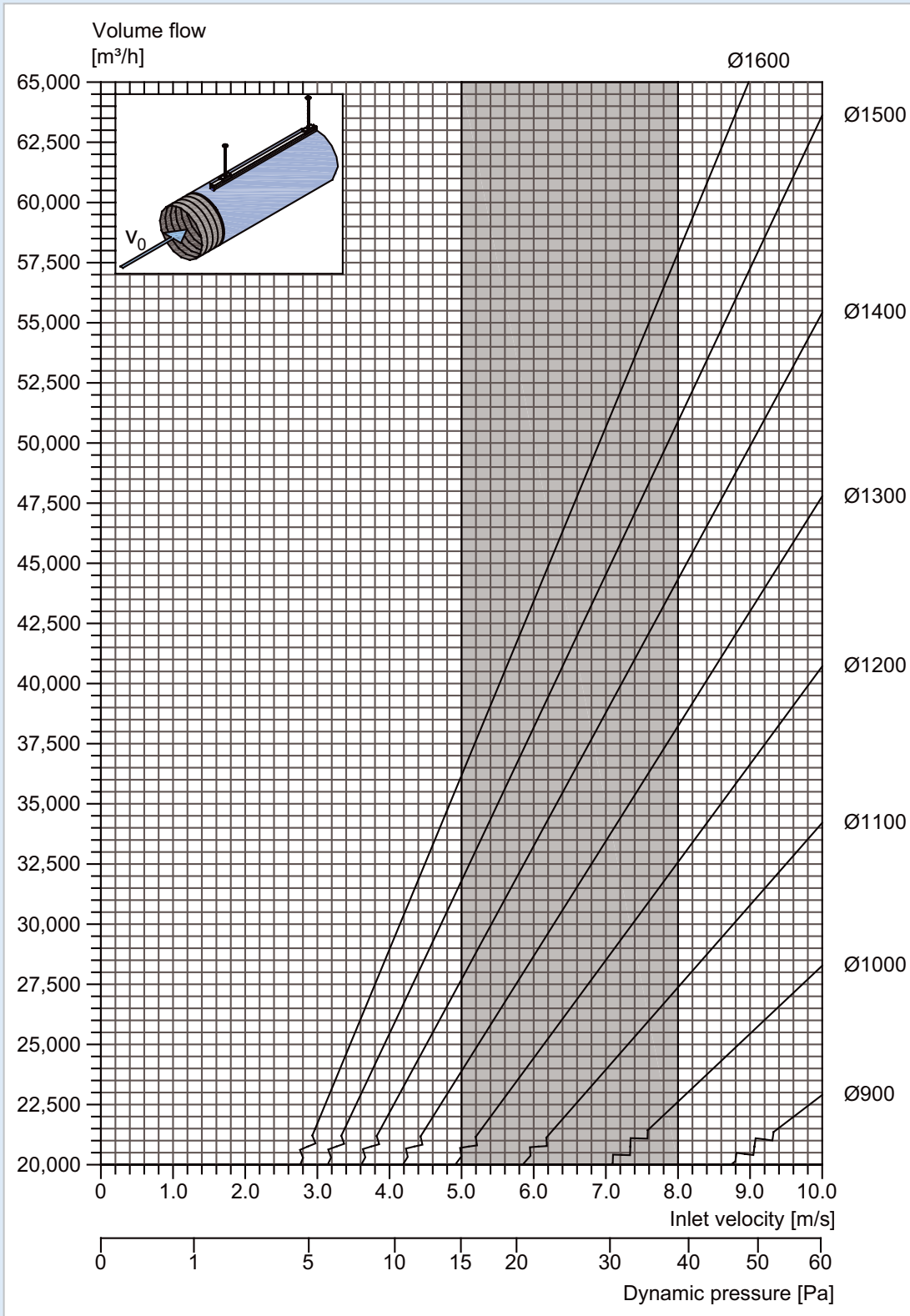
DATASHEET 3

DETERMINING THE DUCT DIAMETER



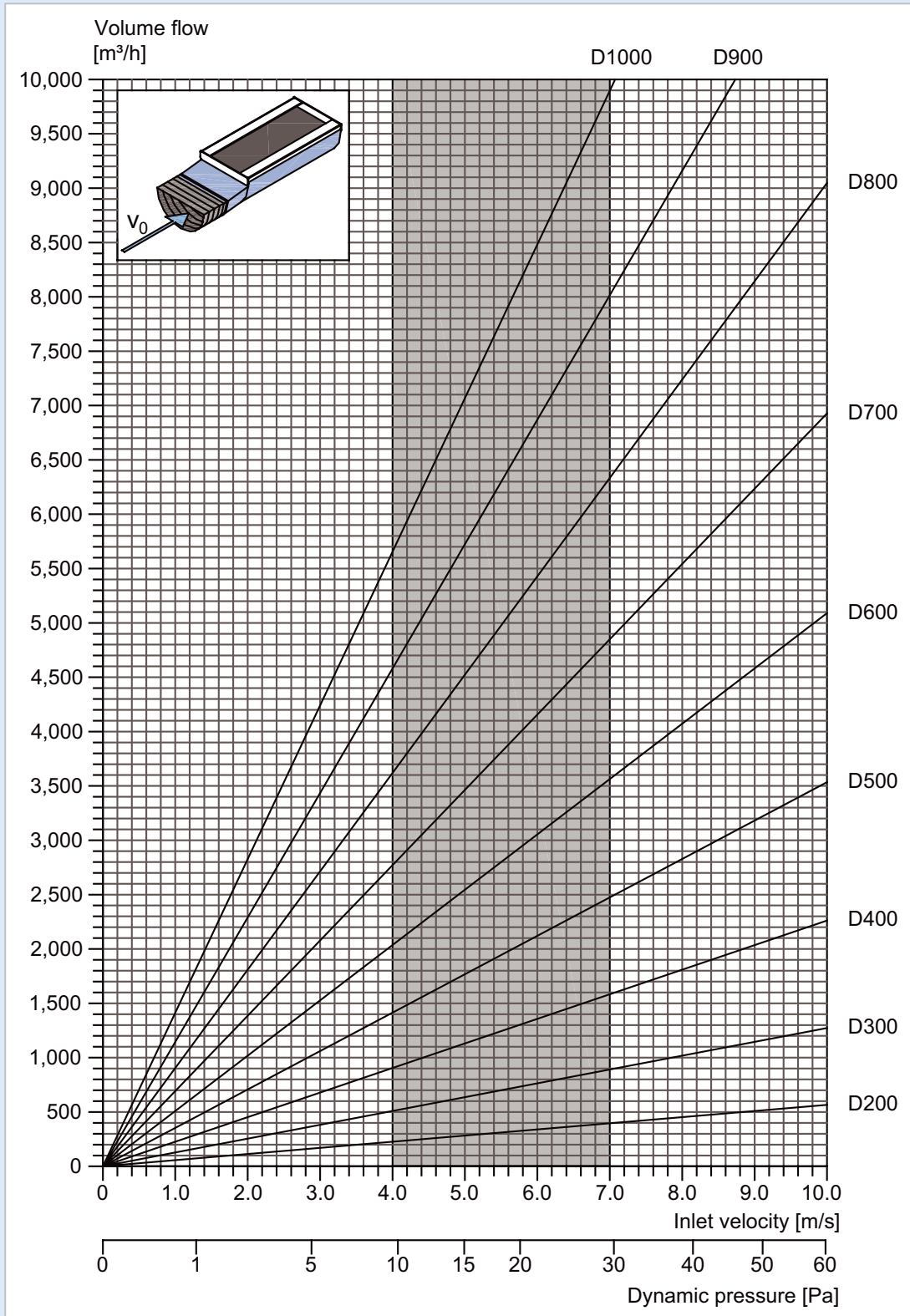
# DATASHEET 4

## DETERMINING THE DUCT DIAMETER



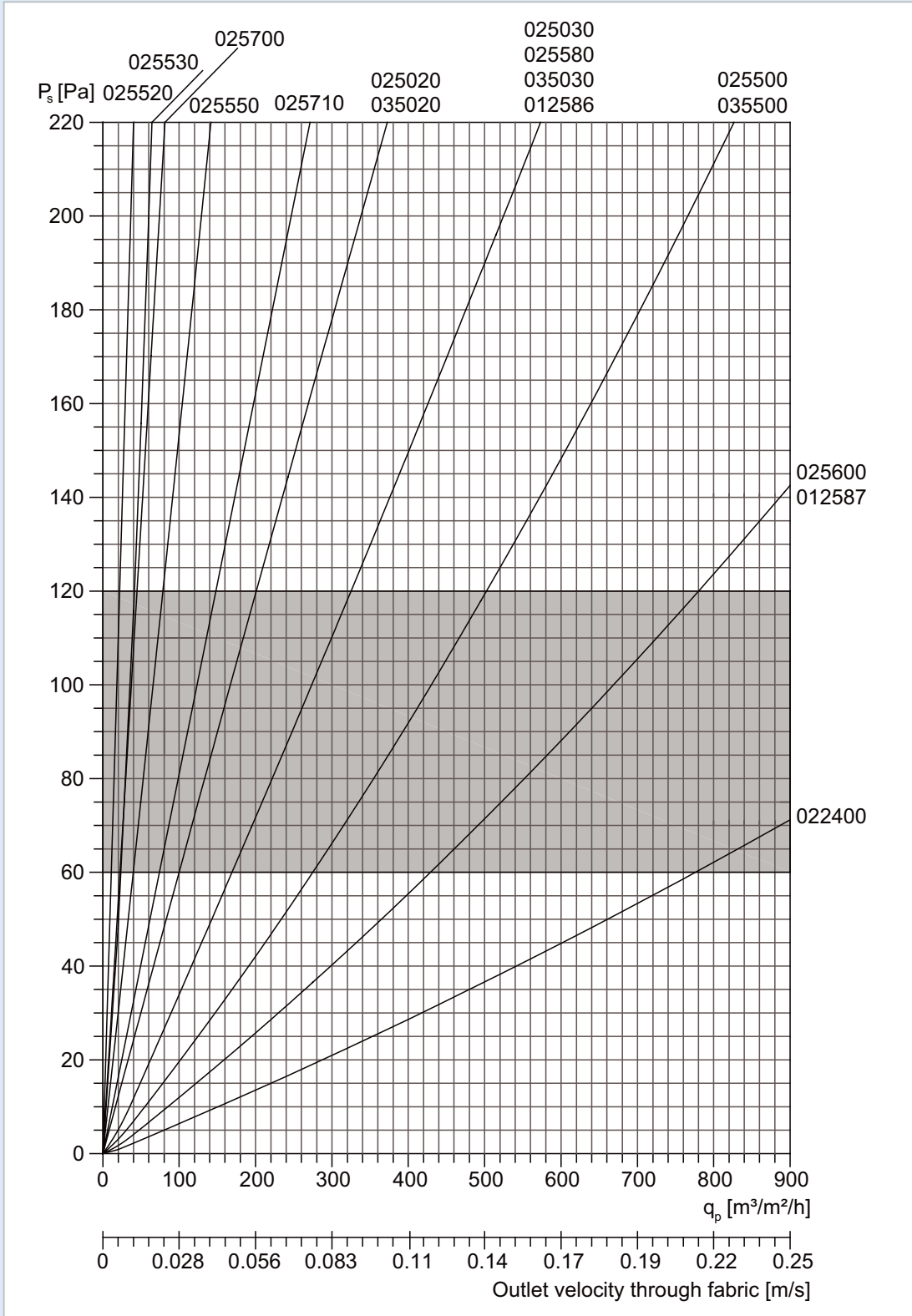
DATASHEET 5

DETERMINING THE DUCT DIAMETER



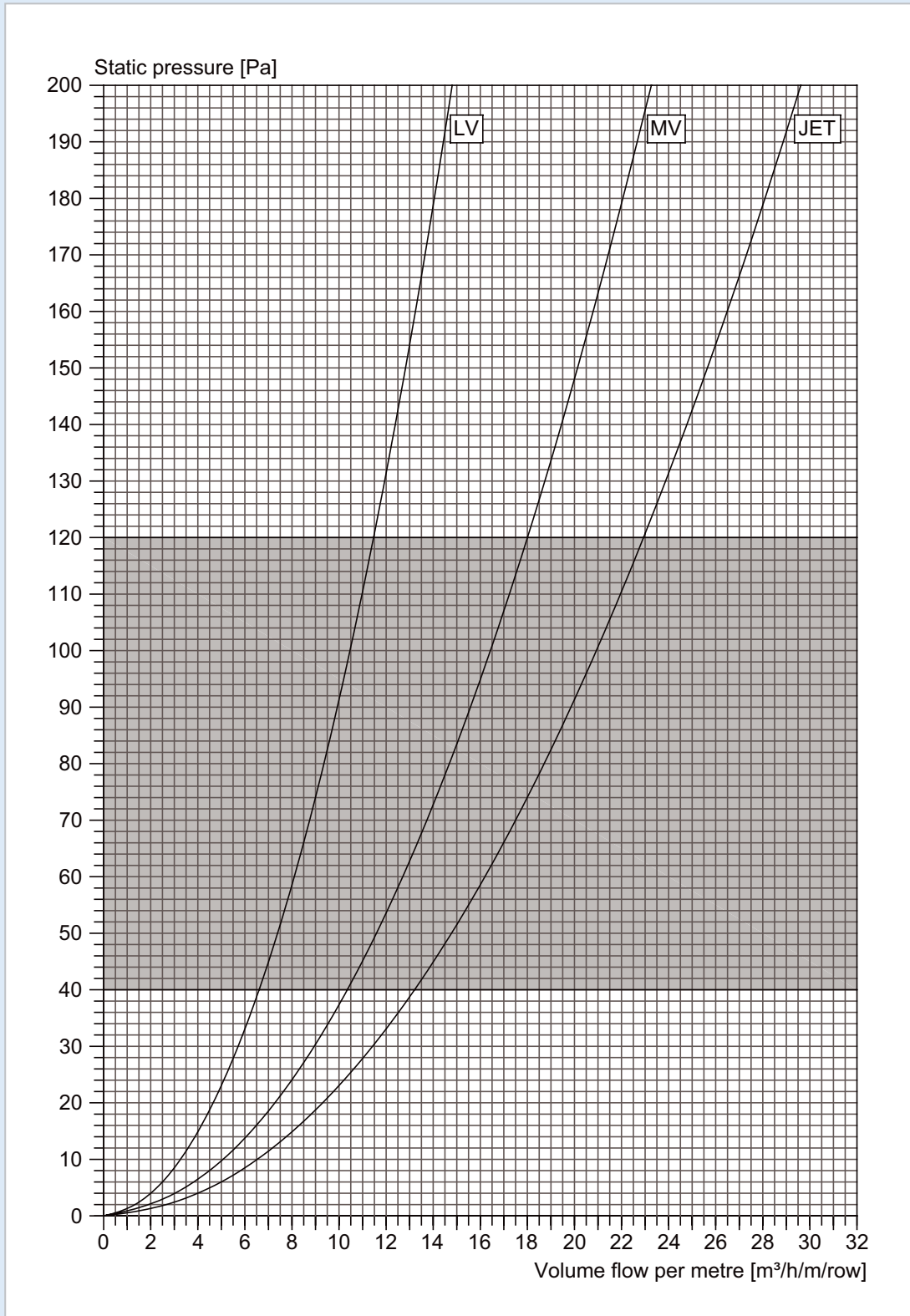
# DATASHEET 6

## PERMEABILITY DIAGRAM



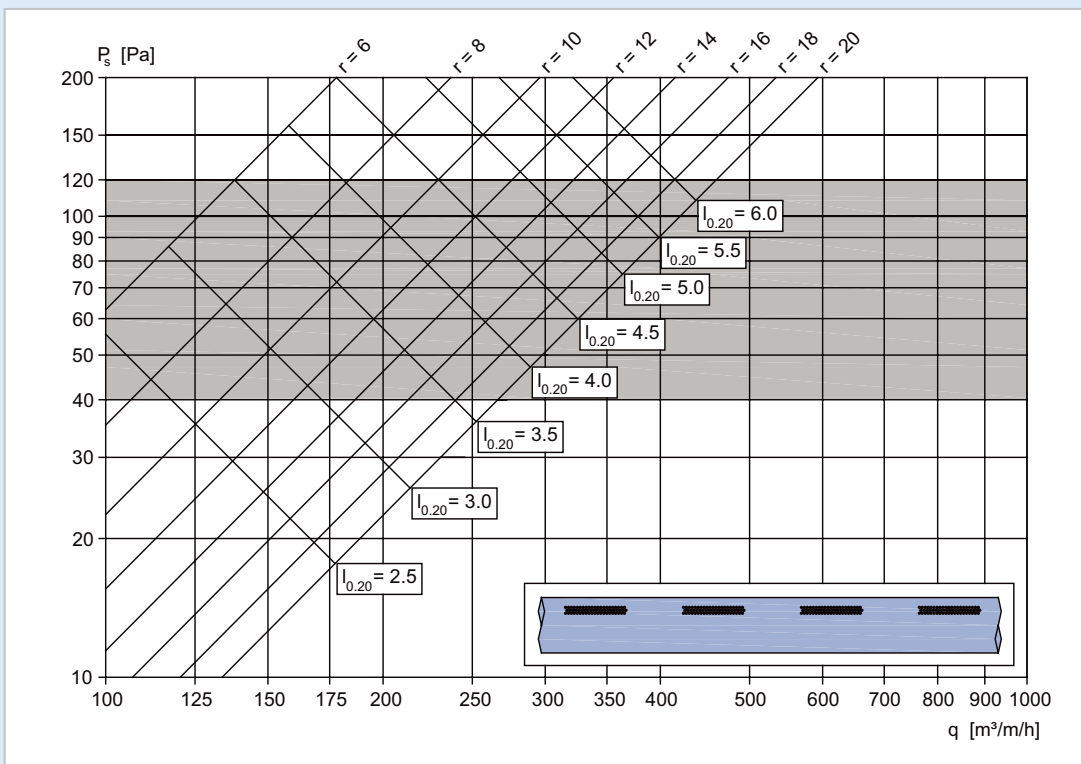
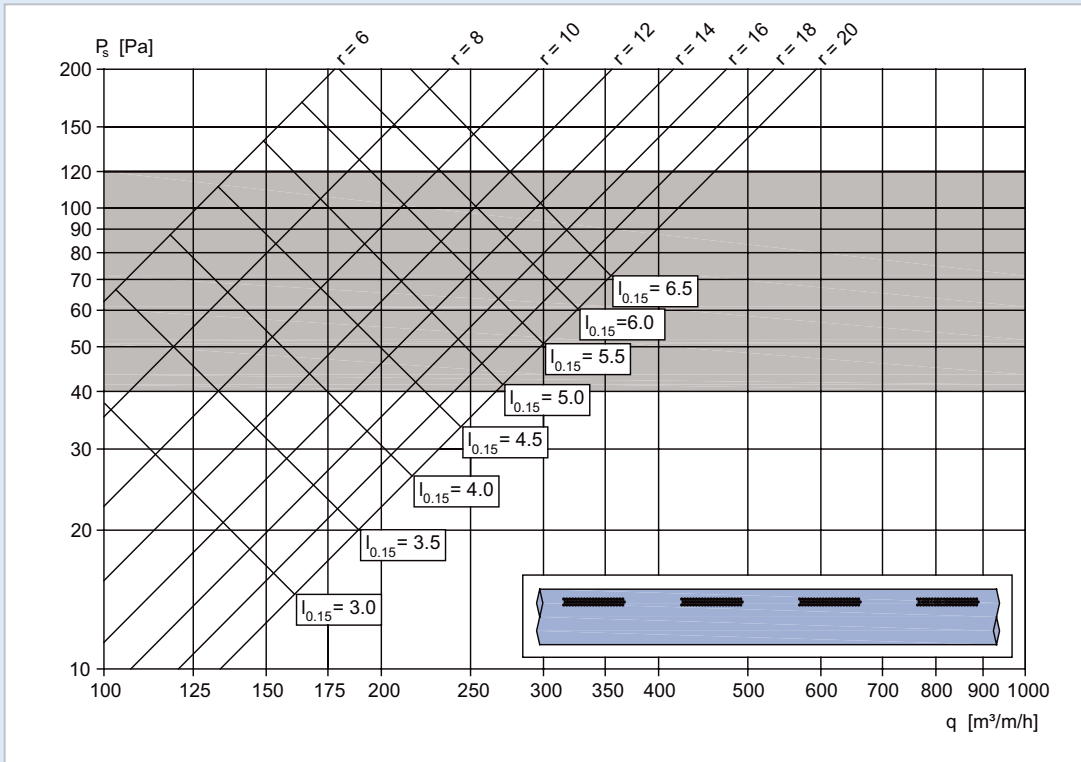
DATASHEET 7

PRESSURE LOSS DIAGRAM KE-INJECT LV, MV AND JET



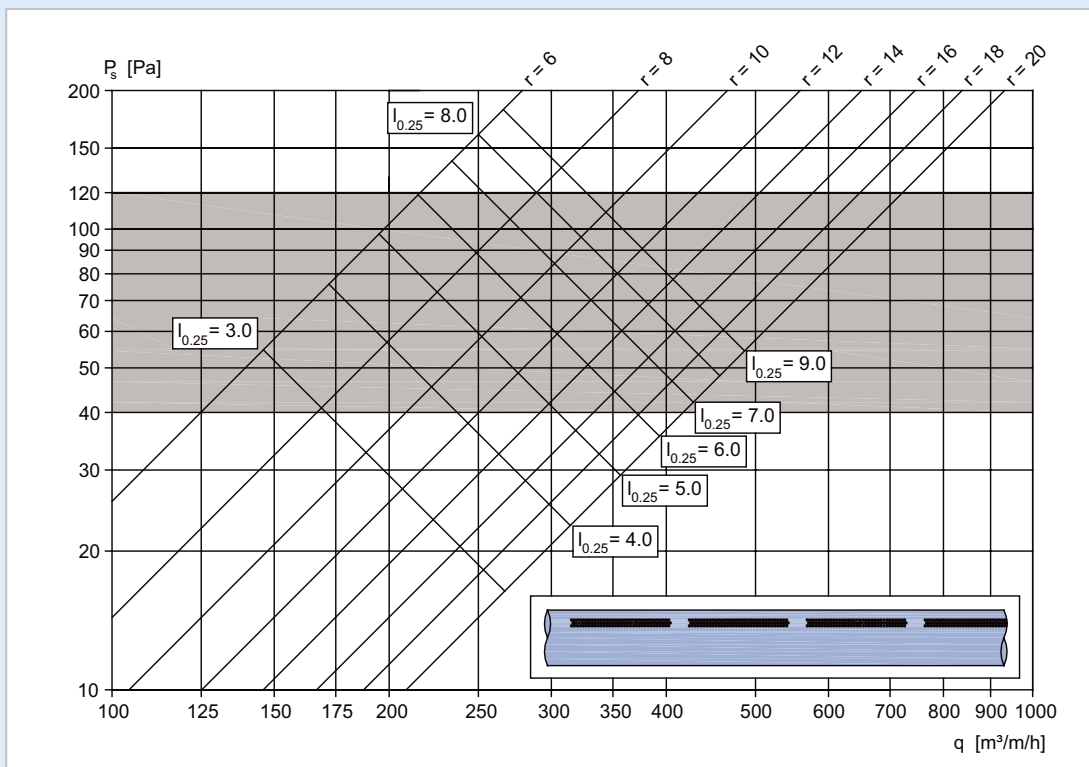
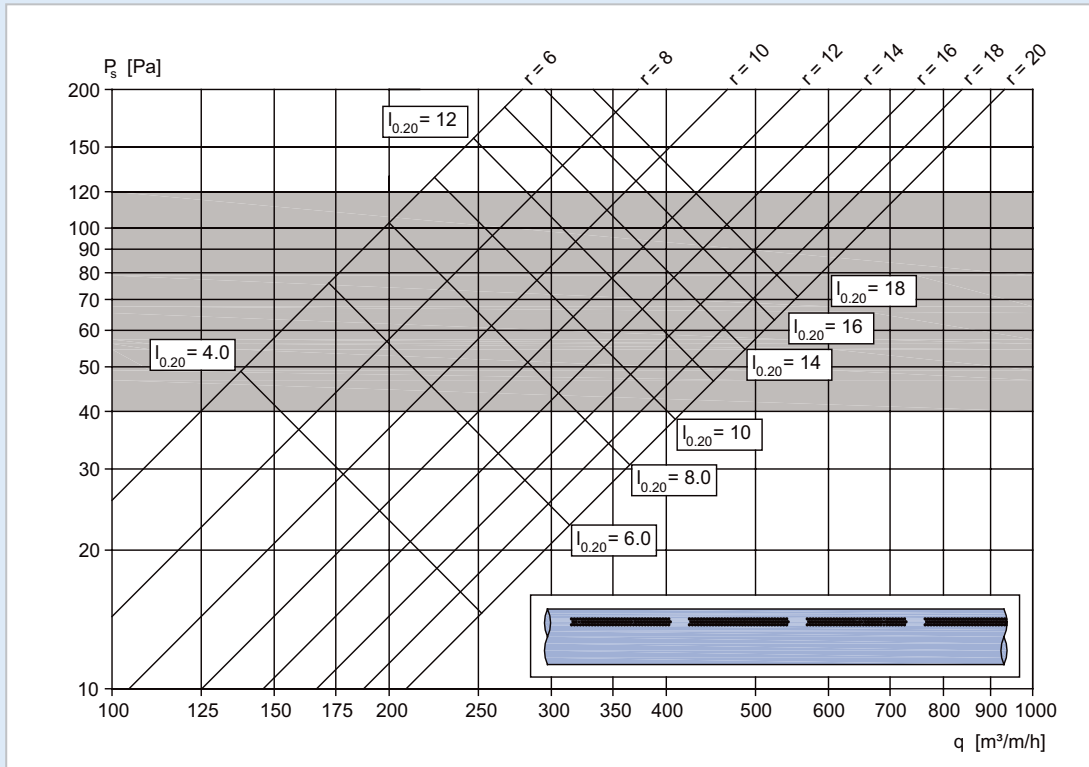
# DATASHEET 8

## KE-INJECT LV - $L_{0.15}$ AND $L_{0.20}$ FOR FREE JETS



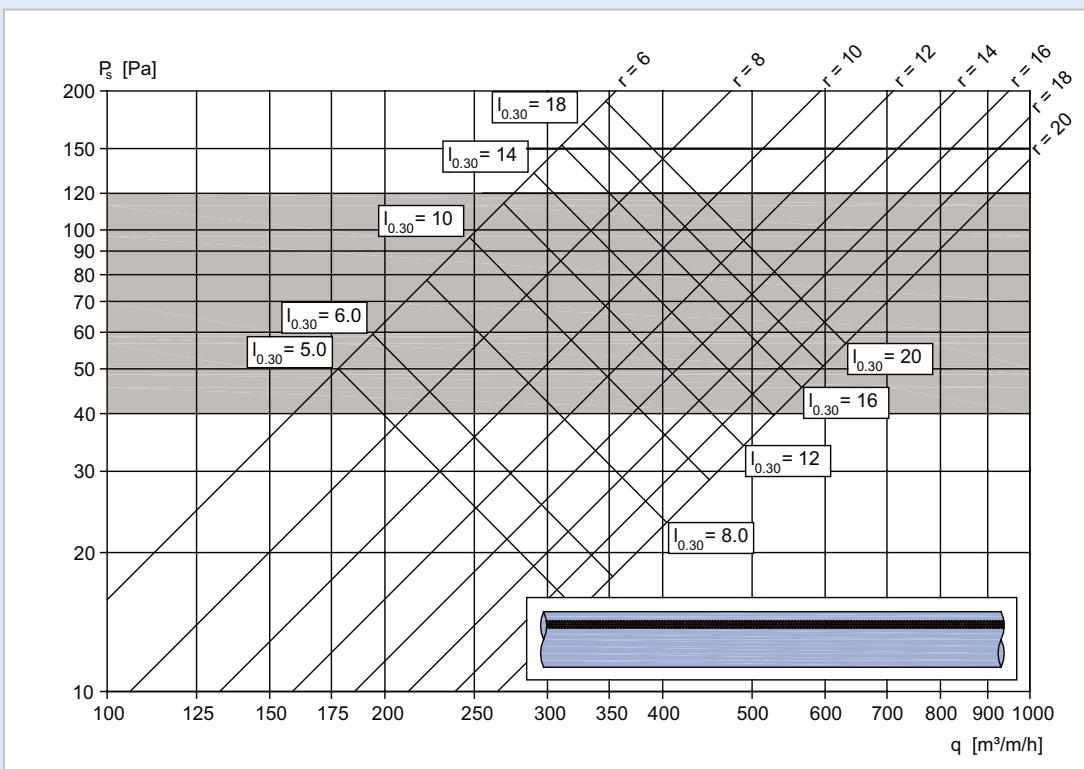
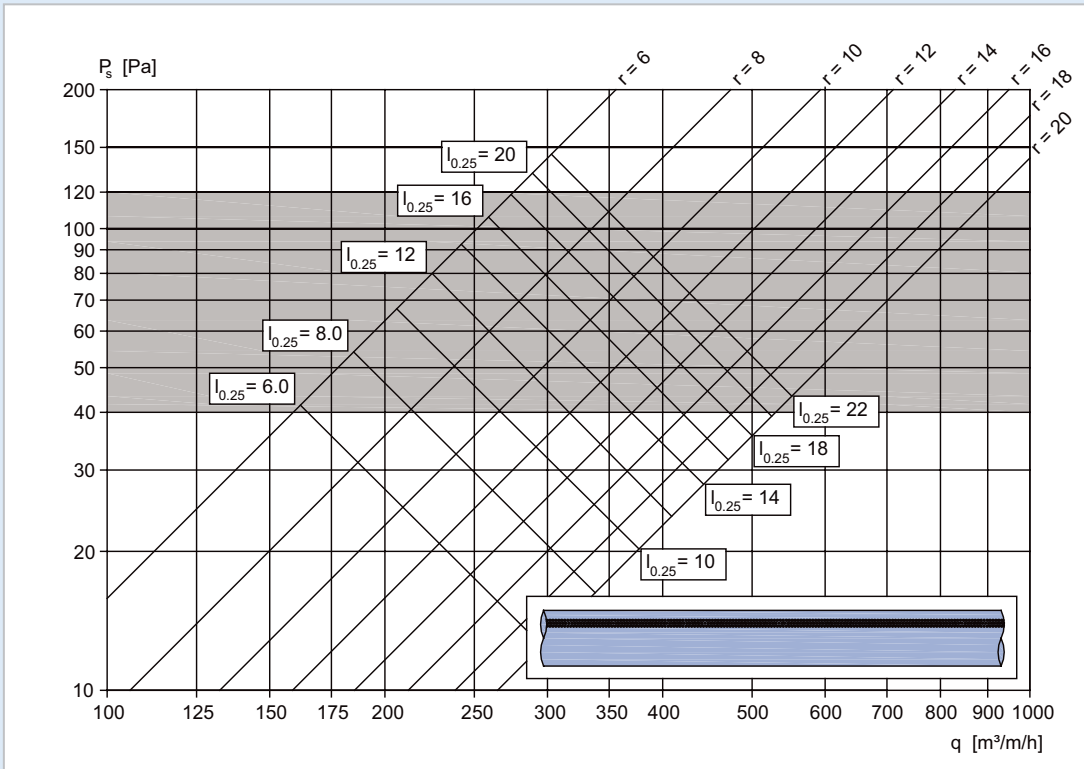
DATASHEET 9

KE-INJECT MV -  $L_{0.20}$  AND  $L_{0.25}$  FOR FREE JETS



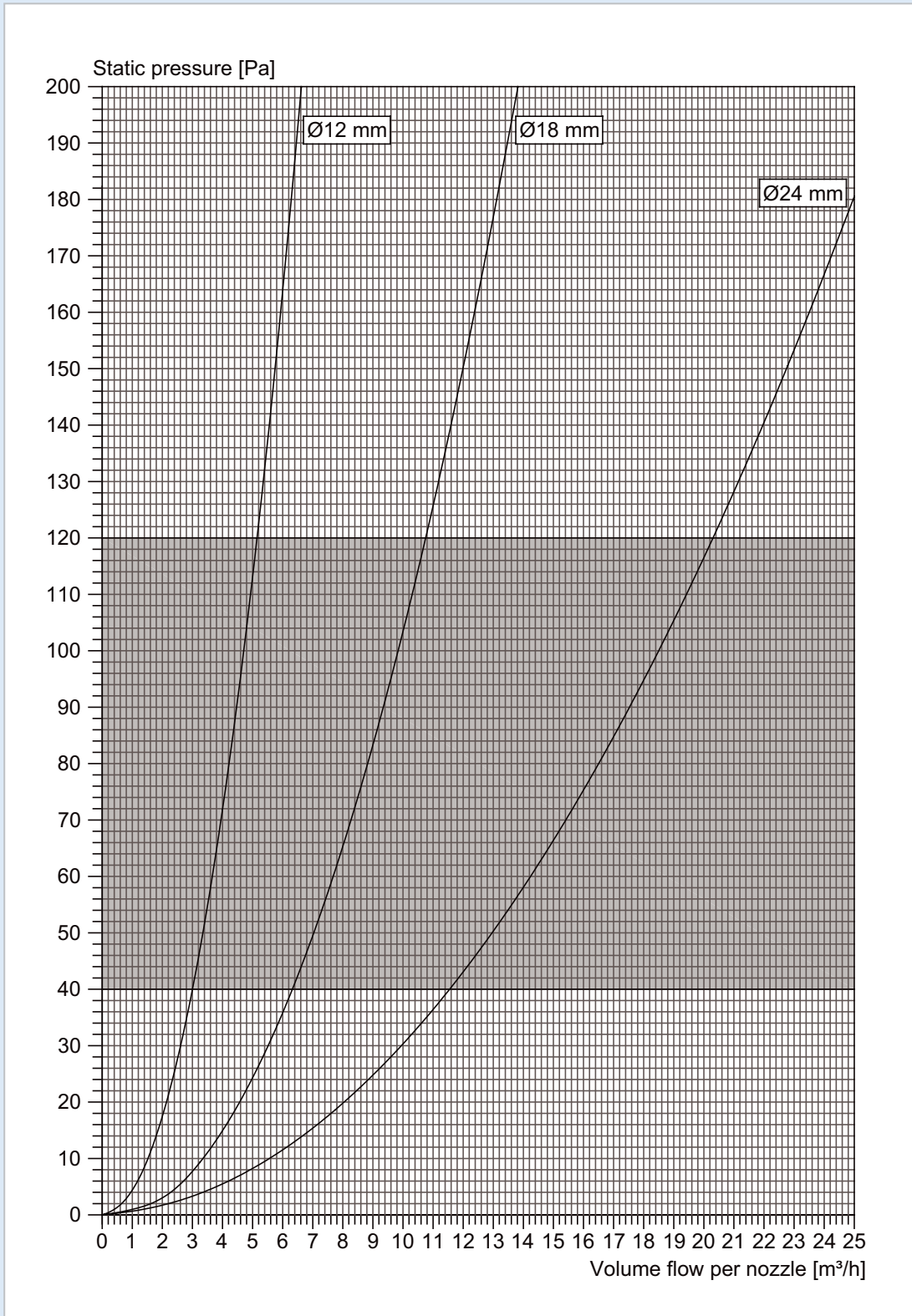
# DATASHEET 10

## KE-INJECT JET - $L_{0.25}$ AND $L_{0.30}$ FOR FREE JETS



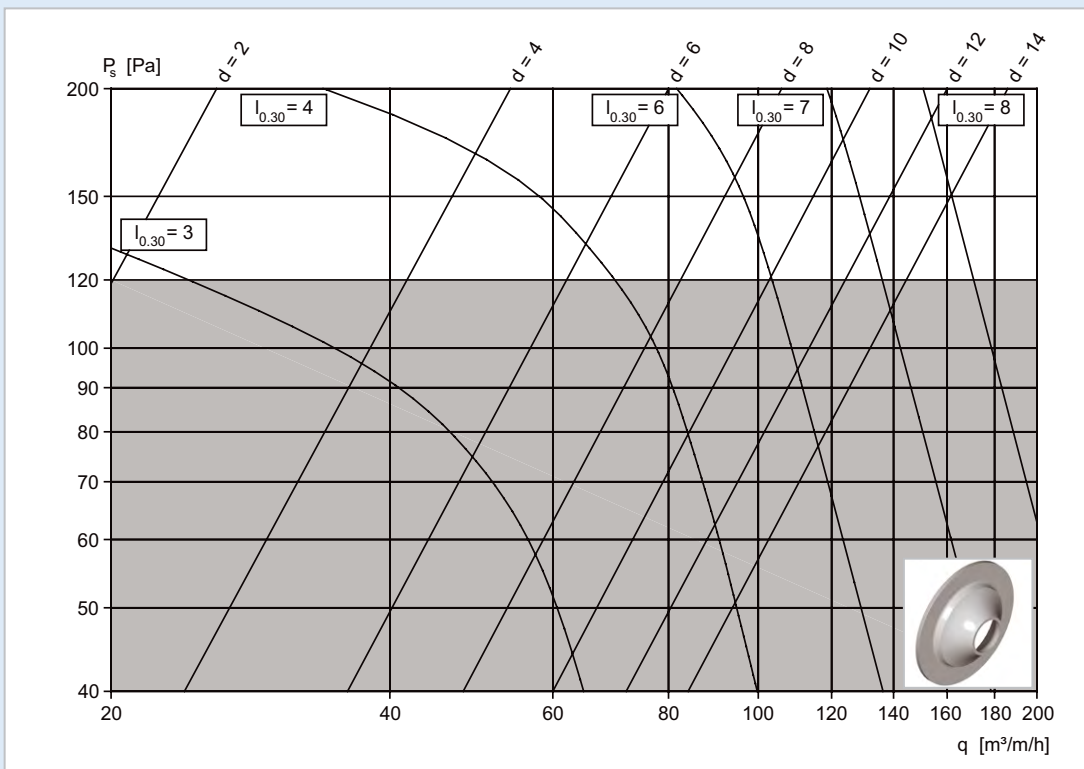
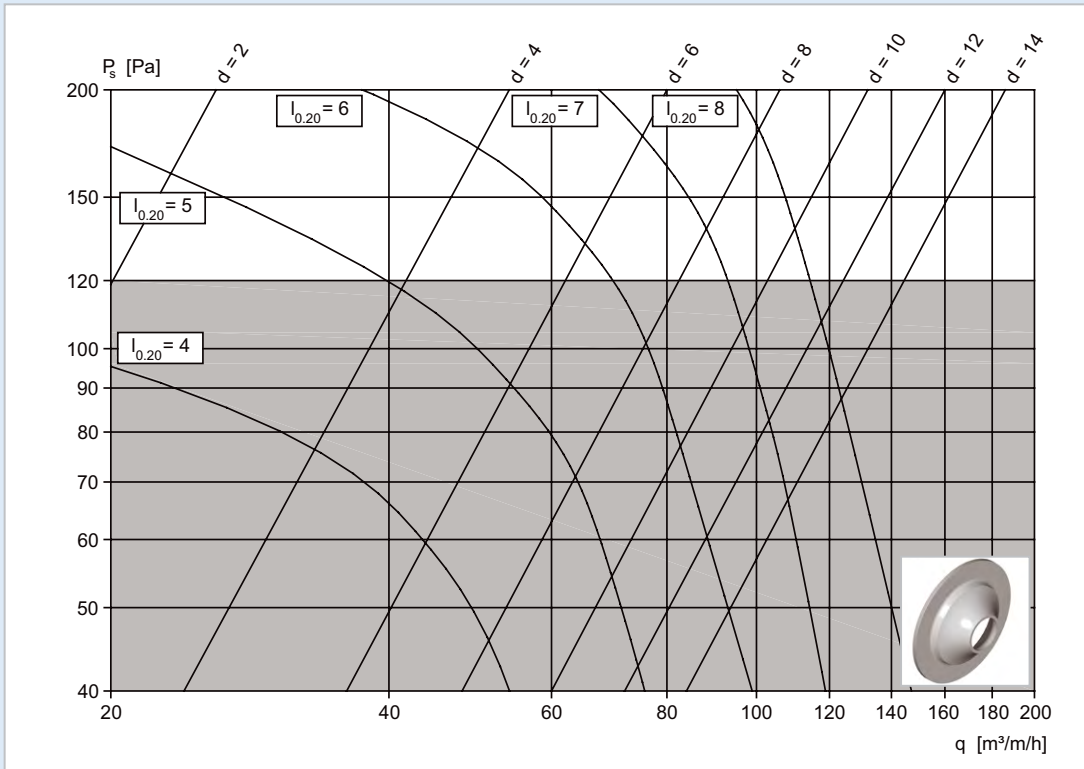
DATASHEET 11

PRESSURE LOSS DIAGRAM KE-DIREJET Ø12, Ø18 AND Ø24 MM



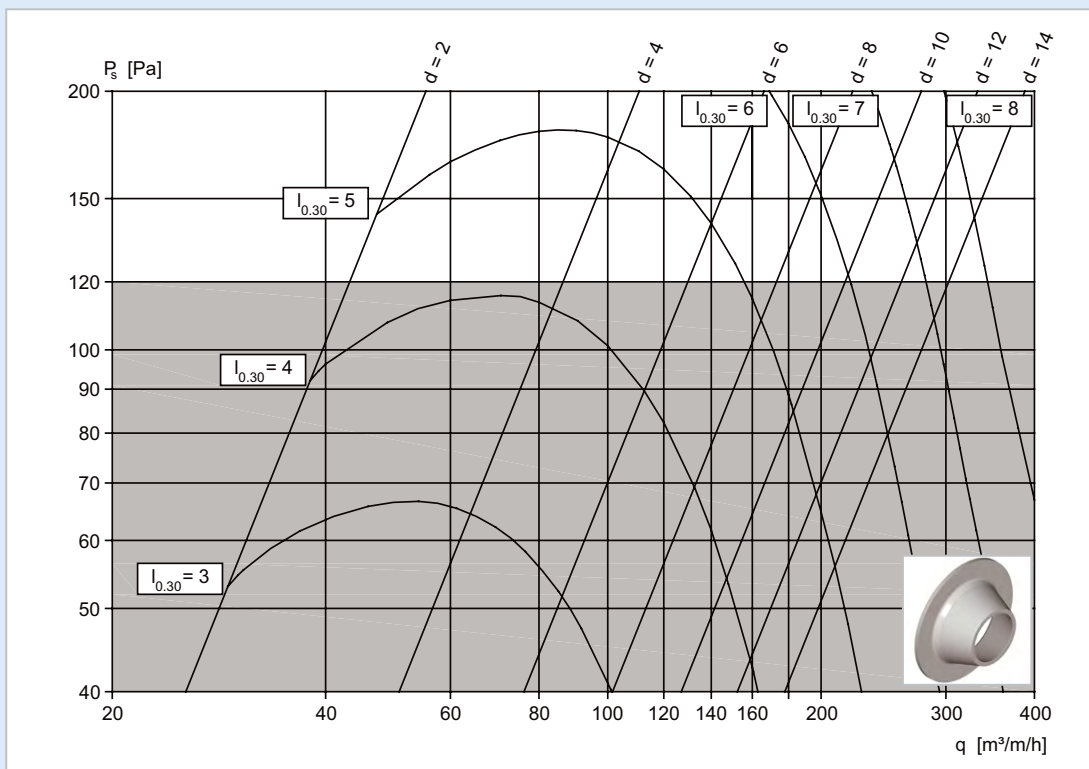
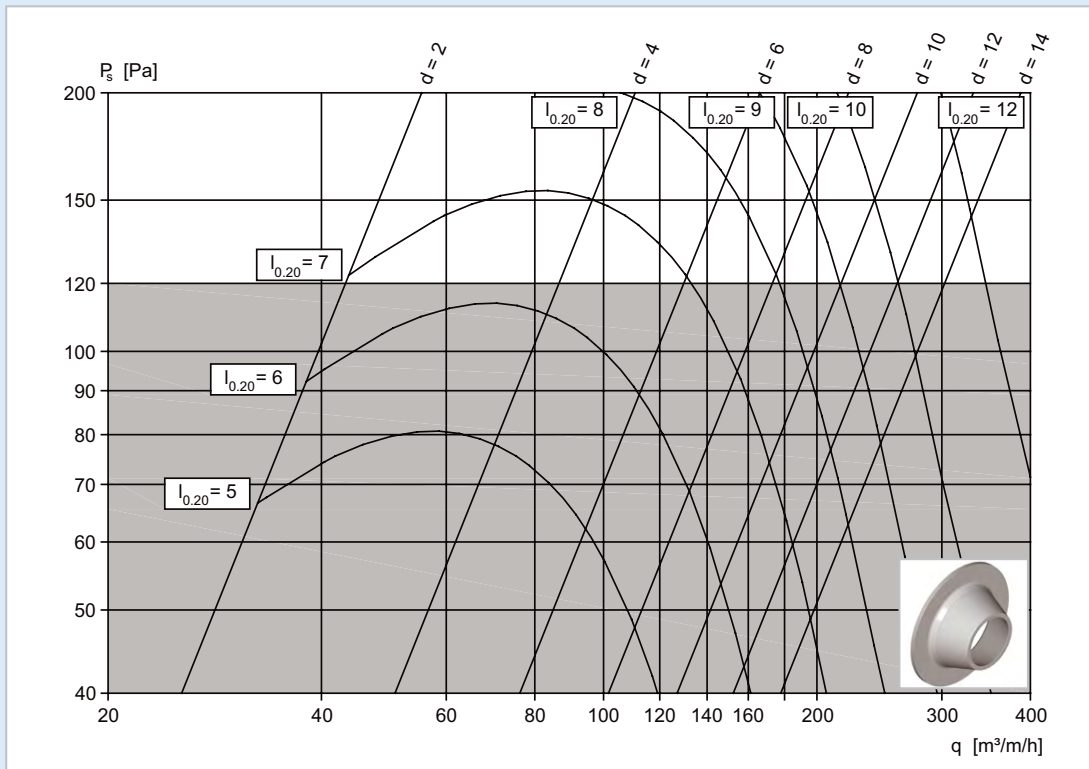
# DATASHEET 12

## KE-DIREJET Ø12 MM - $L_{0.20}$ AND $L_{0.30}$ FOR FREE JETS



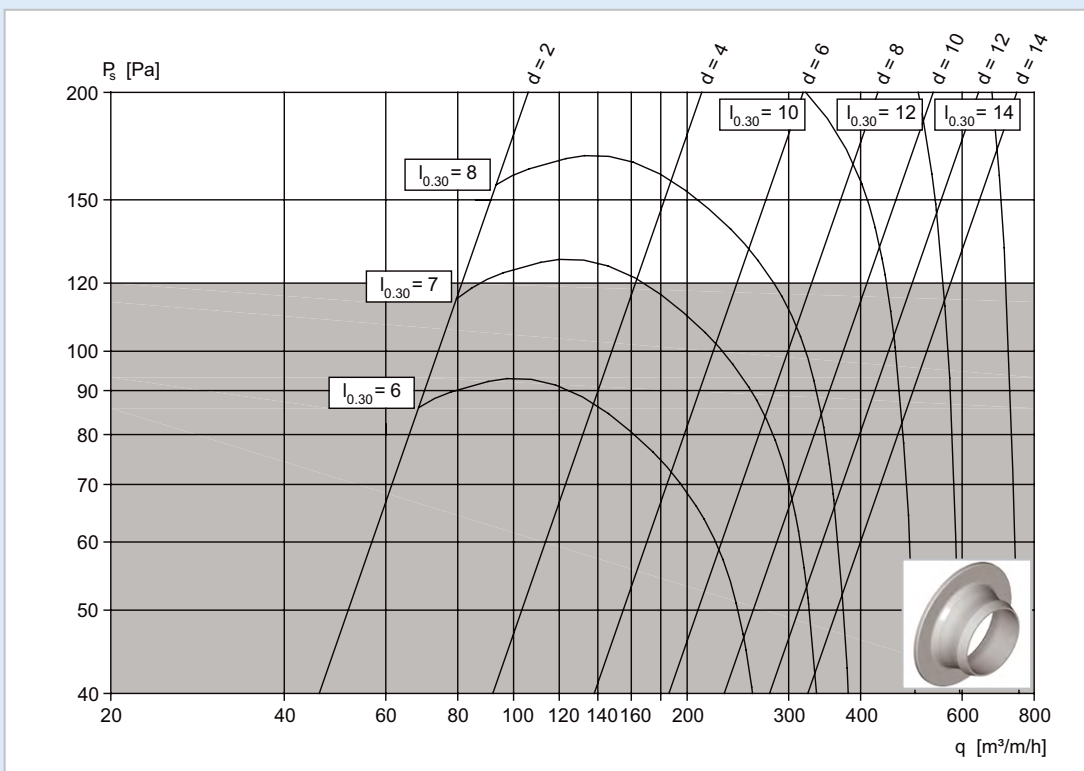
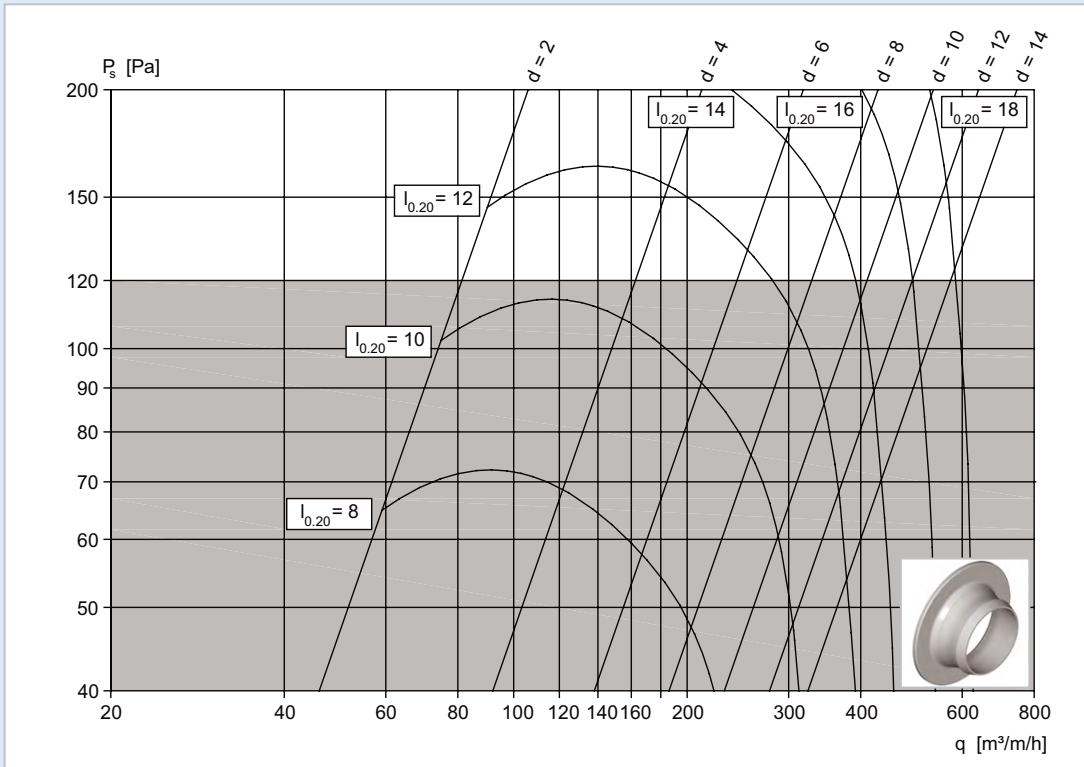
DATASHEET 13

KE-DIREJET Ø18 MM -  $L_{0.20}$  AND  $L_{0.30}$  FOR FREE JETS



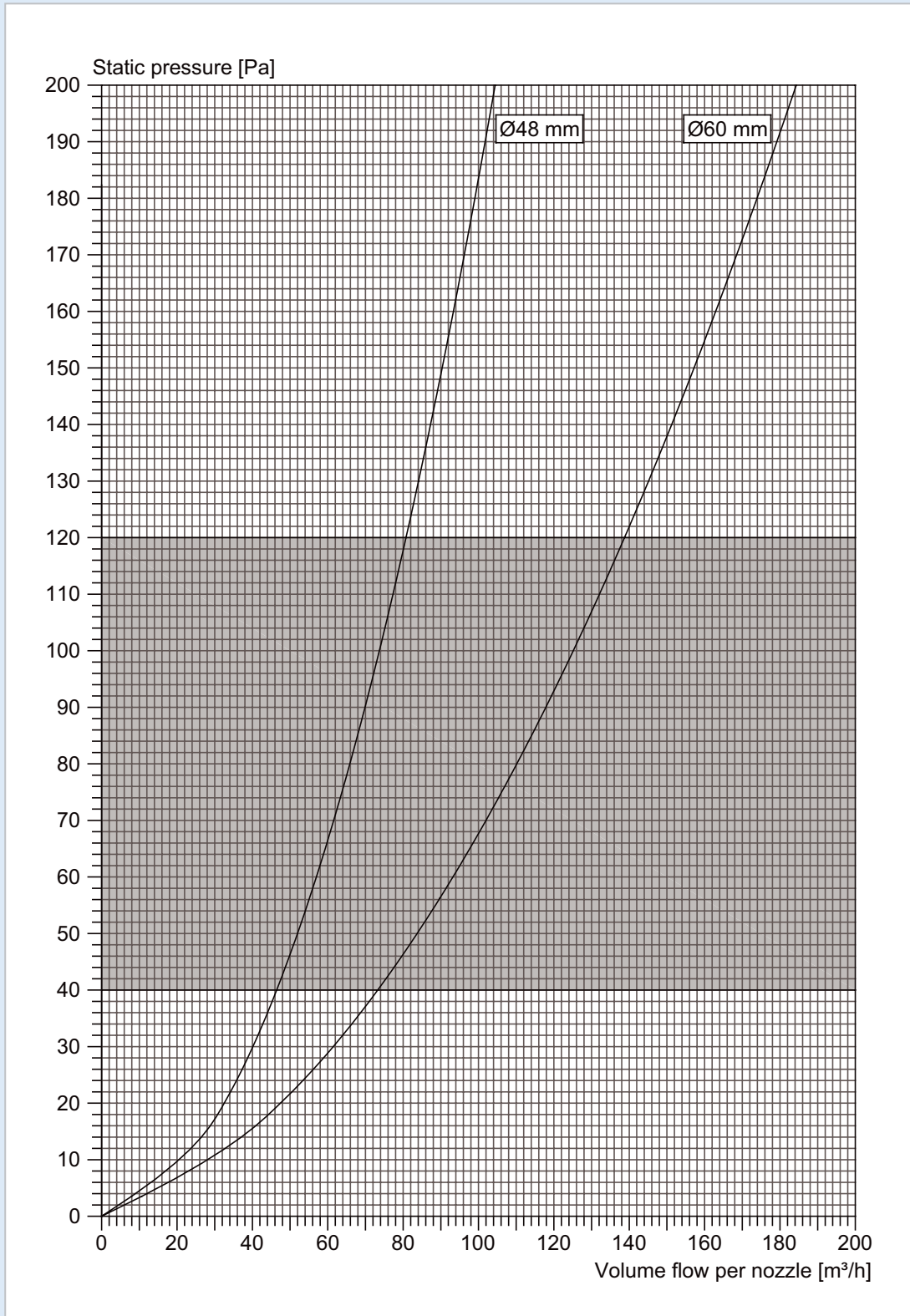
# DATASHEET 14

## KE-DIREJET Ø24 MM - $L_{0.20}$ AND $L_{0.30}$ FOR FREE JETS



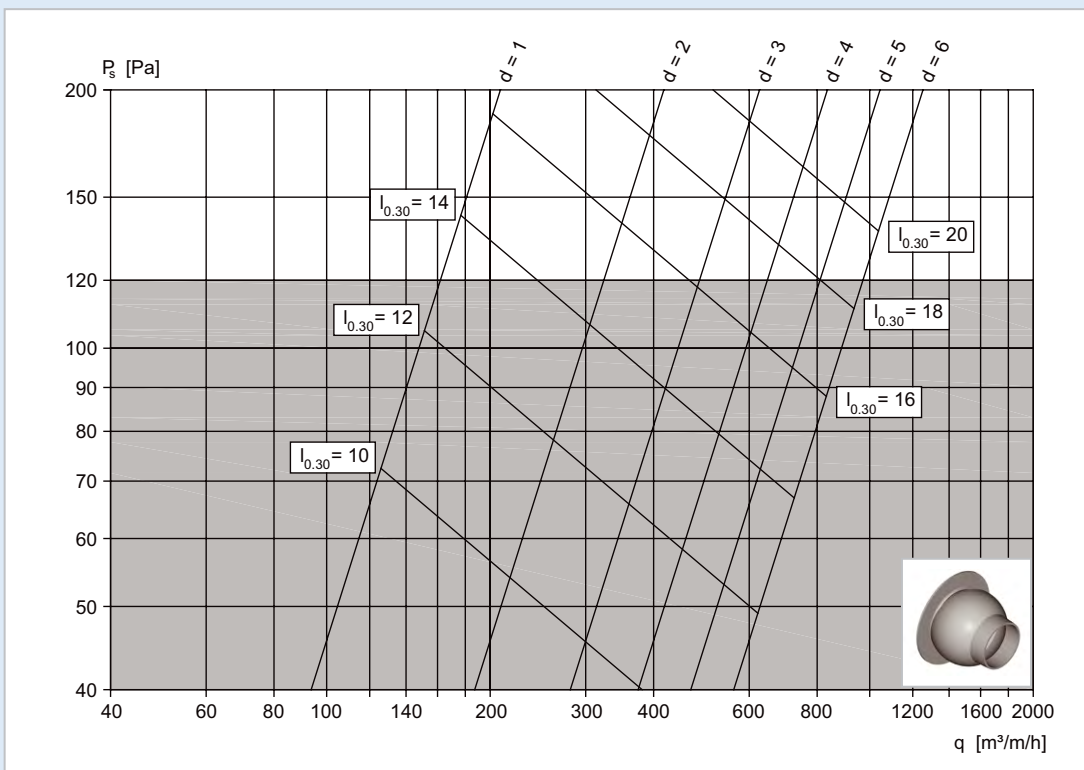
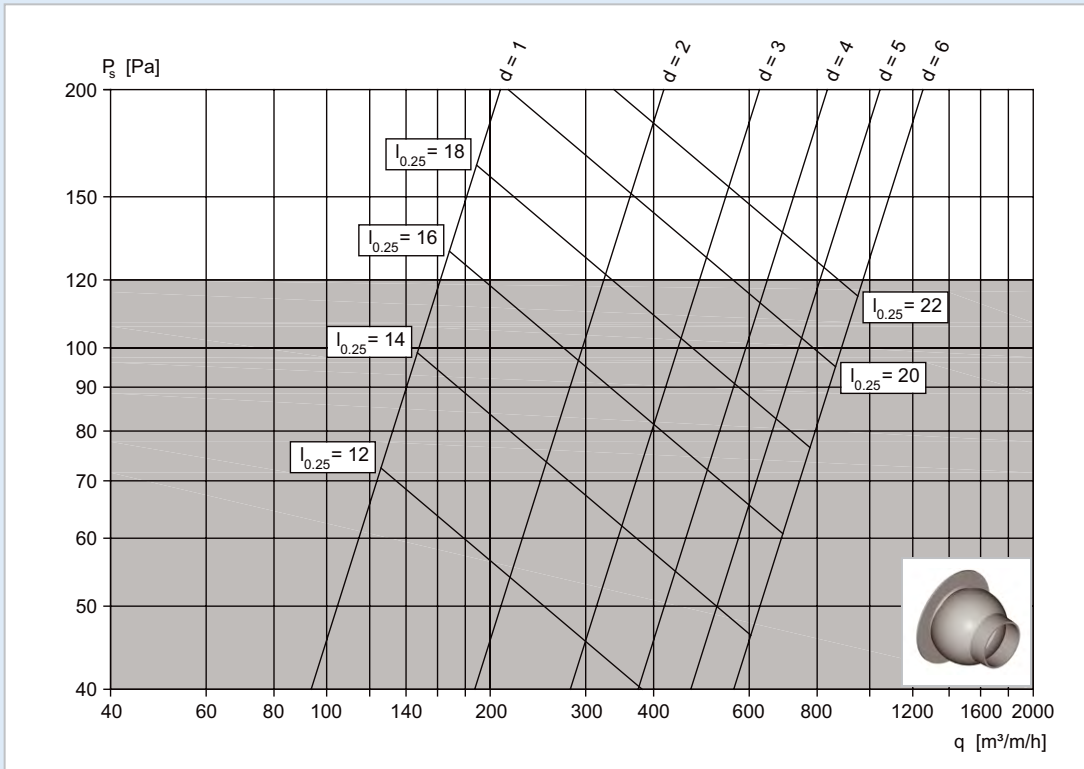
DATASHEET 15

PRESSURE LOSS DIAGRAM KE-DIREJET Ø48 AND Ø60 MM



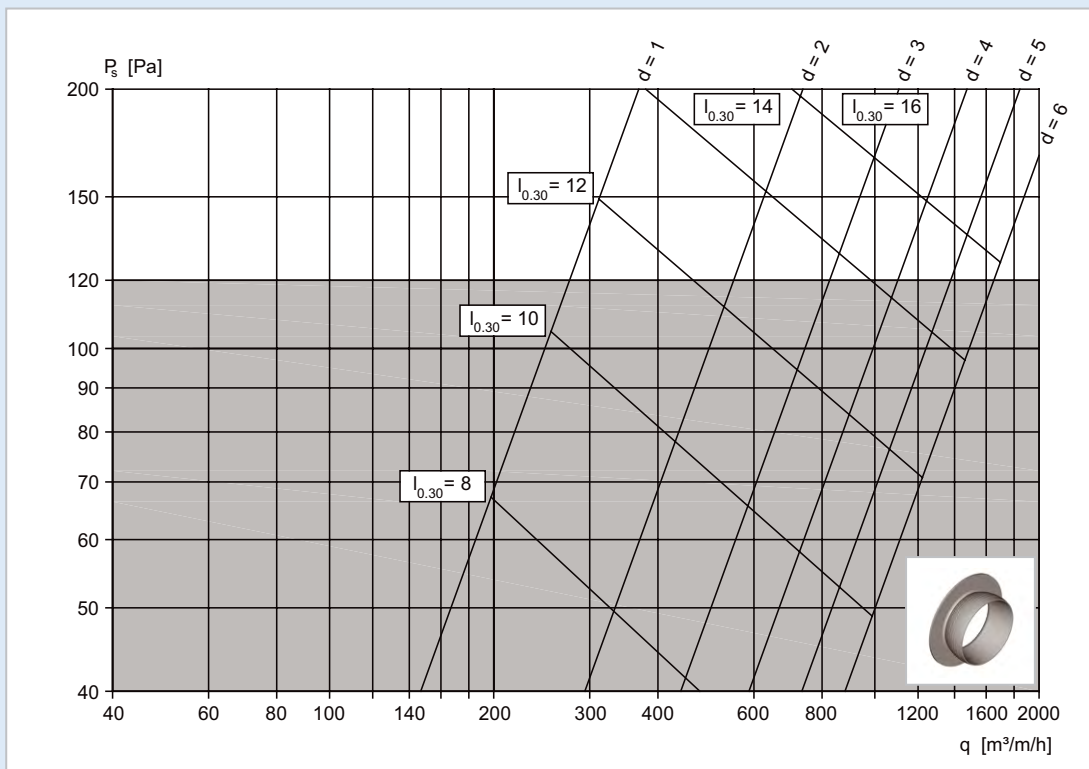
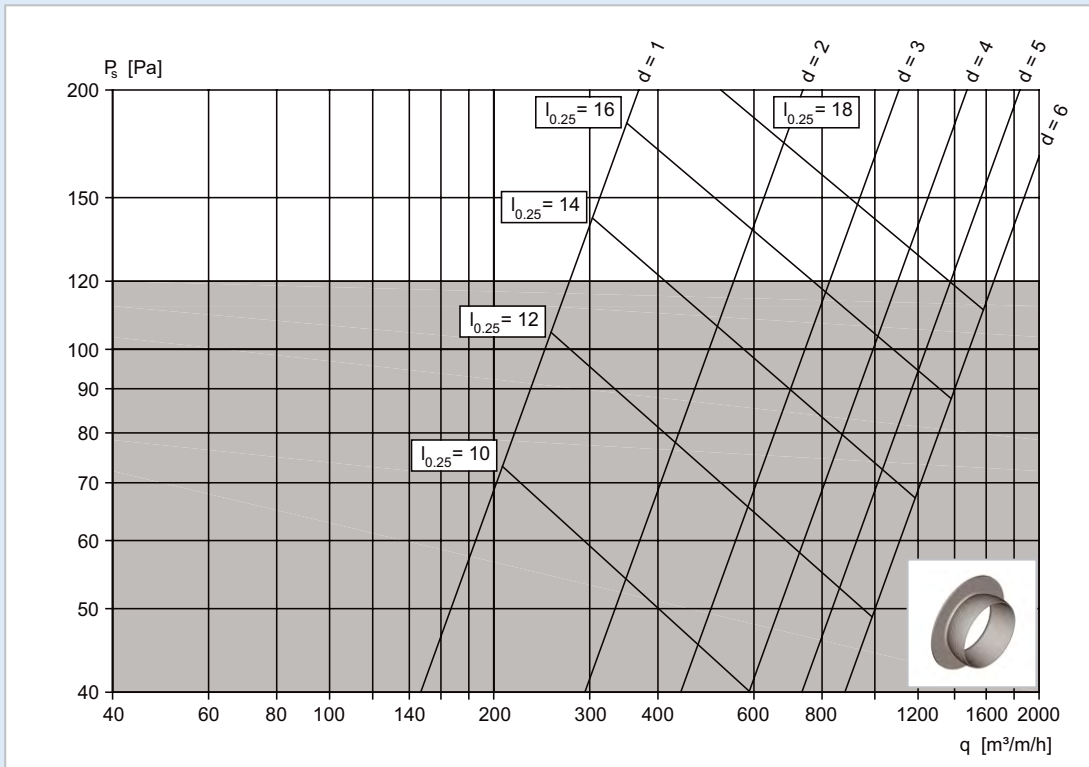
# DATASHEET 16

## KE-DIREJET Ø48 MM - $L_{0.25}$ AND $L_{0.30}$ FOR FREE JETS



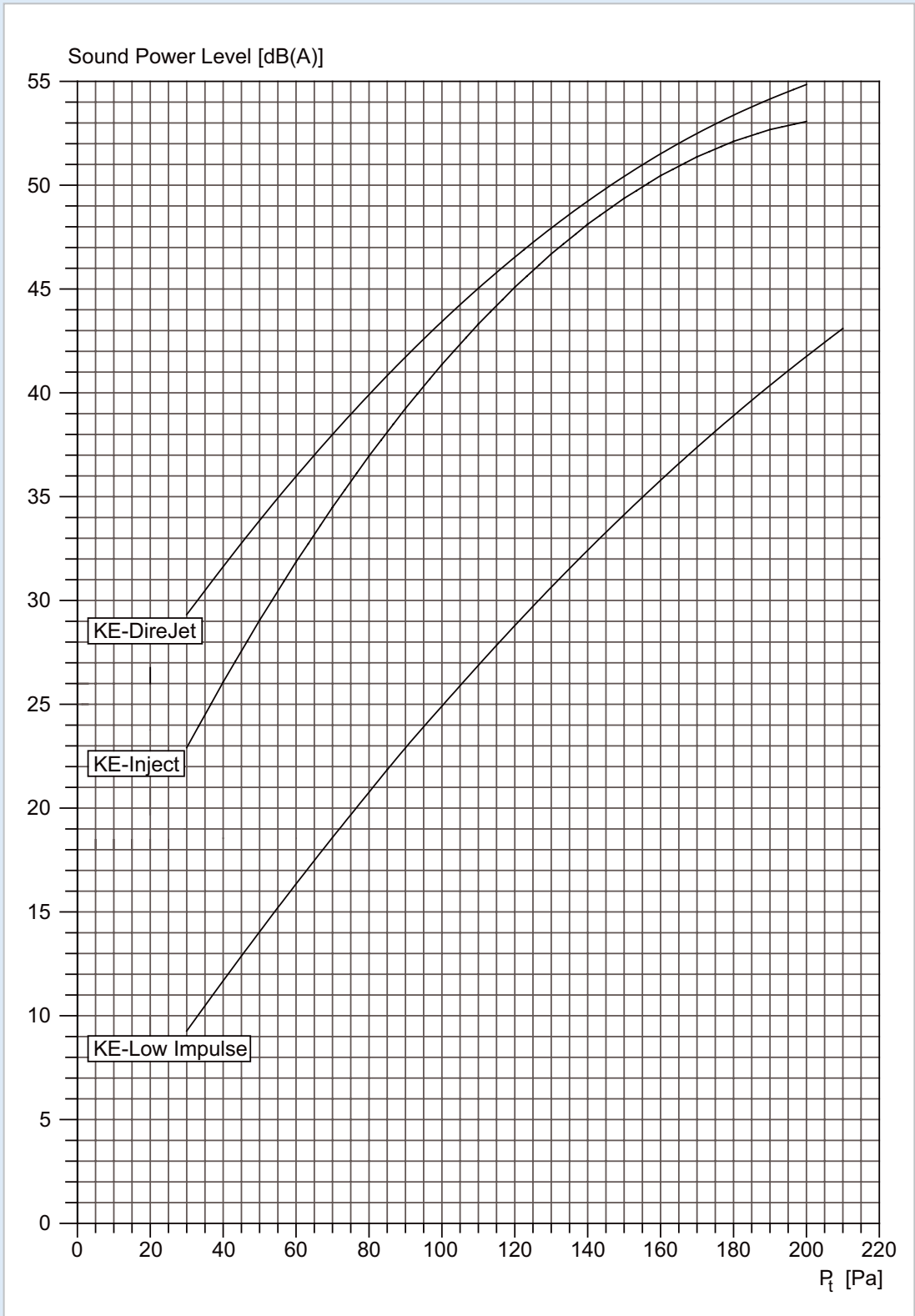
DATASHEET 17

KE-DIREJET Ø60 MM -  $L_{0.25}$  AND  $L_{0.30}$  FOR FREE JETS



# DATASHEET 18

## DETERMINING BASIC SOUND POWER LEVEL



DATASHEET 19

CORRECTION FOR SOUND POWER LEVELS

KE-INJECT LOW VELOCITY

Rows	Duct length									
r	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
2	-10.0	-7.0	-5.2	-4.0	-3.0	-2.2	-1.5	-1.0	-0.5	0.0
4	-7.0	-4.0	-2.2	-1.0	0.0	+0.8	+1.5	+2.0	+2.6	+3.0
6	-5.2	-2.2	-0.5	+0.8	+1.8	+2.6	+3.2	+3.8	+4.3	+4.8
8	-4.0	-1.0	+0.8	+2.0	+3.0	+3.8	+4.5	+5.1	+5.6	+6.0
10	-3.0	0.0	+1.8	+3.0	+4.0	+4.8	+5.4	+6.0	+6.5	+7.0
12	-2.2	+0.8	+2.6	+3.8	+4.8	+5.6	+6.2	+6.8	+7.3	+7.8
14	-1.5	+1.5	+3.2	+4.5	+5.4	+6.2	+6.9	+7.5	+8.0	+8.5
16	-1.0	+2.0	+3.8	+5.1	+6.0	+6.8	+7.5	+8.1	+8.6	+9.0
18	-0.5	+2.6	+4.3	+5.6	+6.5	+7.3	+8.0	+8.6	+9.1	+9.5
20	0.0	+3.0	+4.8	+6.0	+7.0	+7.8	+8.5	+9.0	+9.5	+10.0

KE-INJECT MEDIUM VELOCITY

Rows	Duct length									
r	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
2	-8.0	-5.0	-3.3	-2.0	-1.0	-0.3	+0.4	+1.0	+1.5	+2.0
4	-5.0	-2.0	-0.3	+1.0	+2.0	+2.8	+3.4	+4.0	+4.5	+5.0
6	-3.3	-0.3	+1.5	+2.8	+3.7	+4.5	+5.2	+5.8	+6.3	+6.7
8	-2.0	+1.0	+2.8	+4.0	+5.0	+5.8	+6.4	+7.0	+7.5	+8.0
10	-1.0	+2.0	+3.7	+5.0	+5.9	+6.7	+7.4	+8.0	+8.5	+9.0
12	-0.3	+2.8	+4.5	+5.8	+6.7	+7.5	+8.2	+8.8	+9.3	+9.7
14	+0.4	+3.4	+5.2	+6.4	+7.4	+8.2	+8.9	+9.4	+10.0	+10.4
16	+1.0	+4.0	+5.8	+7.0	+8.0	+8.8	+9.4	+10.0	+10.5	+11.0
18	+1.5	+4.5	+6.3	+7.5	+8.5	+9.3	+10.0	+10.5	+11.0	+11.5
20	+2.0	+5.0	+6.7	+8.0	+9.0	+9.7	+10.4	+11.0	+11.5	+12.0

KE-INJECT JET

Rows	Duct length									
r	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
2	-7.0	-4.0	-2.2	-1.0	+0.0	+0.8	+1.5	+2.0	+2.6	+3.0
4	-4.0	-1.0	+0.8	+2.0	+3.0	+3.8	+4.5	+5.1	+5.6	+6.0
6	-2.2	+0.8	+2.6	+3.8	+4.8	+5.6	+6.2	+6.8	+7.3	+7.8
8	-1.0	+2.0	+3.8	+5.1	+6.0	+6.8	+7.5	+8.1	+8.6	+9.0
10	+0.0	+3.0	+4.8	+6.0	+7.0	+7.8	+8.5	+9.0	+9.5	+10.0
12	+0.8	+3.8	+5.6	+6.8	+7.8	+8.6	+9.2	+9.8	+10.3	+10.8
14	+1.5	+4.5	+6.2	+7.5	+8.5	+9.2	+9.9	+10.5	+11.0	+11.5
16	+2.0	+5.1	+6.8	+8.1	+9.0	+9.8	+10.5	+11.1	+11.6	+12.0
18	+2.6	+5.6	+7.3	+8.6	+9.5	+10.3	+11.0	+11.6	+12.1	+12.6
20	+3.0	+6.0	+7.8	+9.0	+10.0	+10.8	+11.5	+12.0	+12.6	+13.0

## DATASHEET 20

### CORRECTION FOR SOUND POWER LEVELS

#### KE-DIREJET SYSTEM

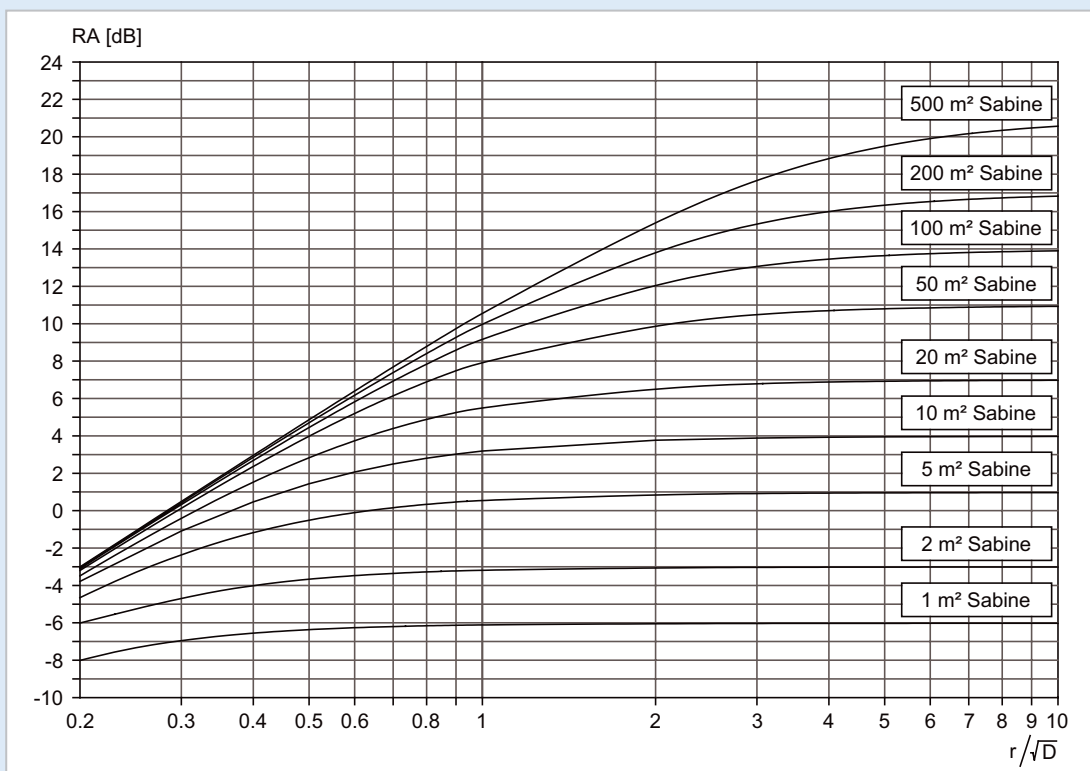
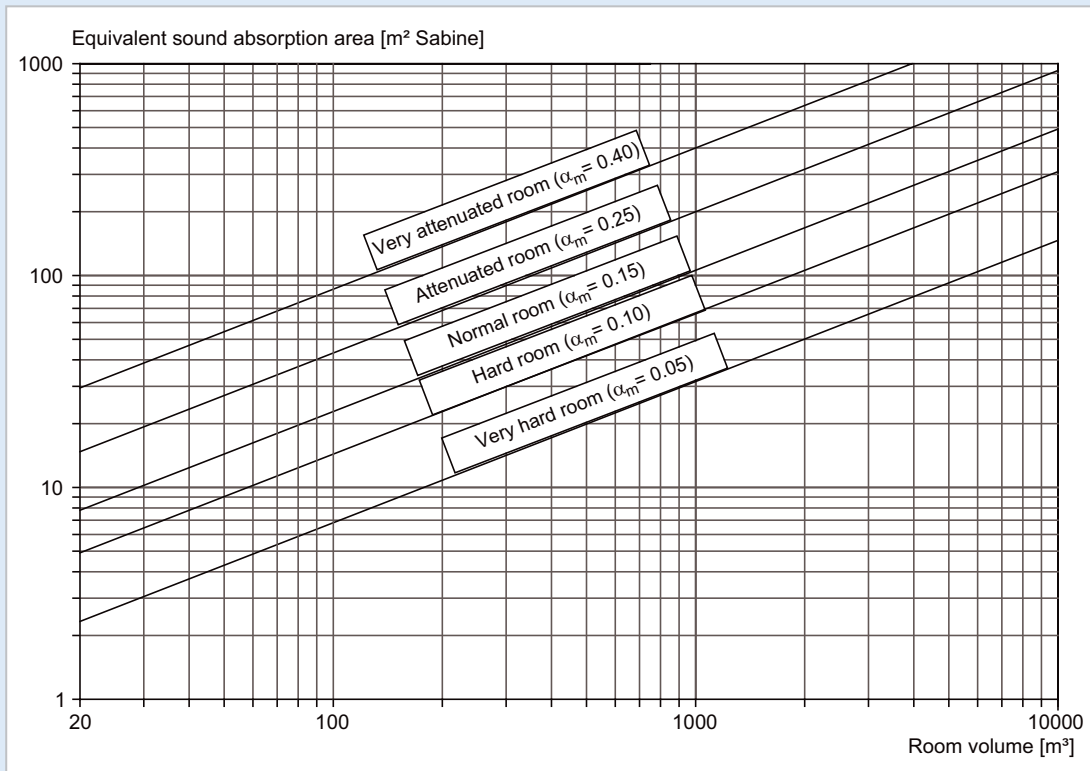
Nozzles	Duct length									
d	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
2	-13.0	-10.0	-8.2	-7.0	-6.0	-5.2	-4.6	-4.0	-3.5	-3.0
4	-10.0	-7.0	-5.2	-4.0	-3.0	-2.2	-1.5	-1.0	-0.5	+0.0
6	-8.2	-5.2	-3.5	-2.2	-1.2	-0.5	+0.2	+0.8	+1.3	+1.8
8	-7.0	-4.0	-2.2	-1.0	+0.0	+0.8	+1.5	+2.0	+2.6	+3.0
10	-6.0	-3.0	-1.2	+0.0	+1.0	+1.8	+2.4	+3.0	+3.5	+4.0
12	-5.2	-2.2	-0.5	+0.8	+1.8	+2.6	+3.2	+3.8	+4.3	+4.8
14	-4.6	-1.5	+0.2	+1.5	+2.4	+3.2	+3.9	+4.5	+5.0	+5.4
16	-4.0	-1.0	+0.8	+2.0	+3.0	+3.8	+4.5	+5.1	+5.6	+6.0
18	-3.5	-0.5	+1.3	+2.6	+3.5	+4.3	+5.0	+5.6	+6.1	+6.5
20	-3.0	+0.0	+1.8	+3.0	+4.0	+4.8	+5.4	+6.0	+6.5	+7.0
22	-2.6	+0.4	+2.2	+3.4	+4.4	+5.2	+5.9	+6.4	+6.9	+7.4
24	-2.2	+0.8	+2.6	+3.8	+4.8	+5.6	+6.2	+6.8	+7.3	+7.8
26	-1.9	+1.1	+2.9	+4.1	+5.1	+5.9	+6.6	+7.2	+7.7	+8.1
28	-1.5	+1.5	+3.2	+4.5	+5.4	+6.2	+6.9	+7.5	+8.0	+8.5
30	-1.2	+1.8	+3.5	+4.8	+5.7	+6.5	+7.2	+7.8	+8.3	+8.8
32	-1.0	+2.0	+3.8	+5.1	+6.0	+6.8	+7.5	+8.1	+8.6	+9.0
34	-0.7	+2.3	+4.1	+5.3	+6.3	+7.1	+7.7	+8.3	+8.8	+9.3
36	-0.5	+2.6	+4.3	+5.6	+6.5	+7.3	+8.0	+8.6	+9.1	+9.5
38	-0.2	+2.8	+4.5	+5.8	+6.8	+7.6	+8.2	+8.8	+9.3	+9.8
40	+0.0	+3.0	+4.8	+6.0	+7.0	+7.8	+8.5	+9.0	+9.5	+10.0

#### KE-LOW IMPULSE SYSTEM

	Duct length									
	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
Corr.	-3.0	+0.0	+1.8	+3.0	+4.0	+4.8	+5.5	+6.0	+6.5	+7.0

DATASHEET 21

DETERMINING ROOM ATTENUATION







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 Denmark

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 Fax + 45 75 36 20 20  
[www.ke-fibertec.com](http://www.ke-fibertec.com)  
[info@ke-fibertec.dk](mailto:info@ke-fibertec.dk)