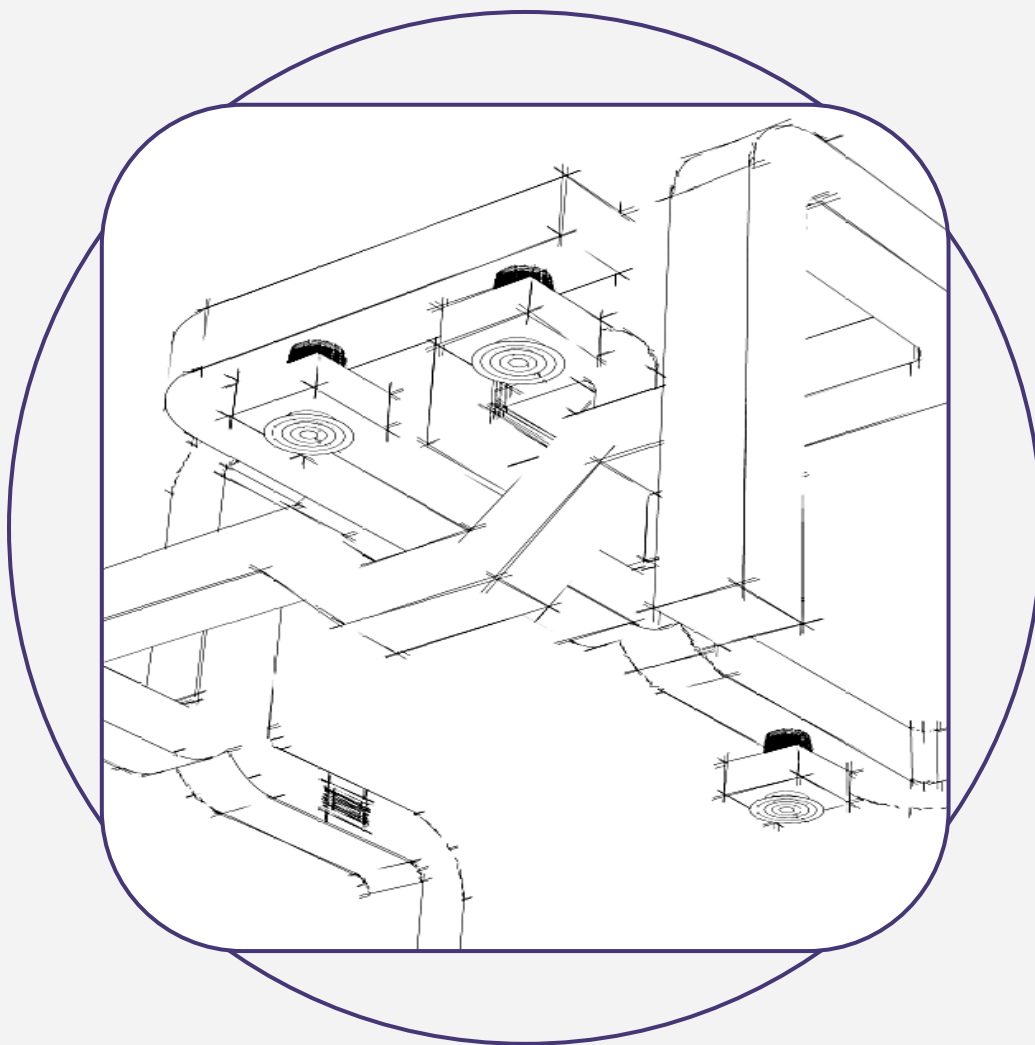




PRE-INSULATED VENTILATION DUCTS

 English version

Design aspects of pre-insulated PU and PIR polyurethane ducts for air distribution in HVAC systems for civil and industrial applications



ANIT HANDBOOKS

ANIT, the Italian National Association for Thermal and acoustic Insulation, periodically publishes documents on topics related to energy efficiency and acoustic insulation of buildings.

The subjects covered include legislation, relevant technical standards, construction technologies, installation guidelines and more.

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INTRODUCTION

Air distribution through ducts concerns both new buildings and buildings undergoing renovation for various types of use: residential, commercial, industrial, sports, healthcare, research, etc.

Air ducts are subject to various requirements in order to perform their task of distributing air.

Many of these requirements are closely linked to issues that ANIT has been addressing for a long time:

- **thermal insulation** performance, which aims to reduce energy loss;
- **condensation-related** performance, characterized by a minimum degree of thermal insulation to prevent internal or external surface condensation, depending on the conditions of the fluid and the surrounding environment;
- **acoustic insulation** of the duct to limit the propagation and transfer of noise;
- **fire prevention**;
- **sustainability** of products and buildings.

The purpose of the Handbook is to provide a concise overview of the world of air ducts, focusing on thermal insulation and the characteristics of ducts made with pre-insulated PU panels and aluminum cladding. The aim of the document is to raise market awareness about the importance of developing solutions that meet the objectives of reducing consumption and impact.

The technical content and proposed solutions were developed with the contribution of our member company Stiferite, which manufactures and markets systems for ducts made of PU-PIR polyurethane panels.

1 AIR DUCTS

As mentioned, air distribution through ducts concerns both new buildings and renovated buildings with different possible uses, such as residential, commercial, industrial, educational, sports, healthcare, etc., where distribution involves long distances and specific conditions for heat transfer or air quality. Within the design process, the air distribution network plays a primary role, with the ducts ensuring proper air conditioning and ventilation of the spaces. The air distribution network is subject to many interdisciplinary requirements.

Air ducts can be manufactured in different cross-sections and classified as follows:

- uninsulated ducts,
- insulated ducts,
- pre-insulated ducts.



This handbook examines in detail the performance of air ducts consisting of aluminum-coated insulation panels with a thickness of 60 to 200 micrometers, with a polyurethane foam core, connected using special joining systems.



1.1 The regulatory context

We refer to the following Italian and European regulatory references:

- UNI EN 13403:2004 Ventilation for buildings - Non-metallic ducts - Ductwork made of insulating material panels
- UNI EN 12237: 2004 Ventilation for buildings - Duct networks - Strength and tightness of circular ducts made of sheet metal
- UNI EN 1507: 2008 Ventilation for buildings - Rectangular ducts made of sheet metal - Strength and tightness requirements
- UNI EN 15727: 2010 Ventilation for buildings - Ducts and components of duct networks, classification of tightness and testing
- UNI EN 12599: 2012 Ventilation for buildings - Test procedures and measurement methods for the acceptance of ventilation and air conditioning systems

1.2 Requirements for pre-insulated ducts

The UNI EN 13403 standard requires ventilation ducts to have the following characteristics:

- **Air leakage factor and air tightness class:** ducts must be tested to comply with a maximum air leakage in relation to the imposed static pressure difference. The class can be determined based on the test results (in accordance with UNI EN 1507). The measured value is the air leakage factor, expressed in liters per second per square meter of duct surface area.

The table shows the air leakage rates in relation to the duct class (Table 3 in the standard).

static pressure difference [Pa]	Maximum loss [l/(s x m ²)] (surface area)		
	Duct network class		
	Class A	Class B	Class C
400	1.32	0.44	0.14
800	-	0.69	0.23
1000	-	0.80	0.27
1200	-	0.90	0.30
1500	-	1.10	0.36

The duct samples made with PIR polyurethane panels and the available connection systems can achieve air leakage class C and do not undergo deformation such as bulging or sagging under maximum operating pressure.

The image shows an example of a test to measure air leakage.



- **Pressure resistance (without reinforcement):** air ducts and joint connection sections, assembled according to the manufacturer's instructions, must withstand without breaking an internal pressure equal to 2.5 times the maximum positive pressure set by the manufacturer and not less than 200 Pa. The test indicates what is meant by breakage: tears, lacerations, or other openings larger than 4 mm, including accessories.

Pressure resistance tests

The image shows a sample of ducts made with PIR polyurethane panels and the available connection systems which, at the end of the tests, showed no damage or cracks, with a pressure resistance in accordance with UNI EN 13403 equal to 3750 Pa.



- **Bulging and/or caving, air leakage:** no part of the duct shall bulge and/or cave by more than 3% of its width or 30 mm whichever is the greater value.
- **Erosion and particle release:** the material constituting the inner surface of the ducts subjected to standardized tests must not break, flake, or show signs of delamination and erosion. Maximum particle release limits are indicated according to particle size.
- **Facilities for cleaning:** the ductwork shall conform to the requirements specified in ENV 12097. The Isocanale duct resists the cleaning operations equivalent to a life span of 20 years of use (one cleaning operation per year) without any damage. The material on inside surface doesn't break, flake off or show evidence of delamination or erosion.

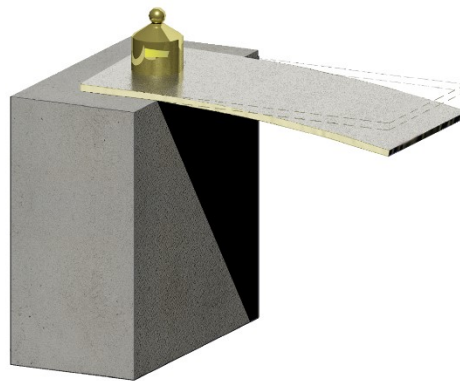
1.3 Panel requirements

The UNI EN 13403 standard defines that the “panel” is composed of a core of insulating material with both sides covered and with the outer layer including a vapor barrier to make the product waterproof.

The panel must meet the following requirements:

- **Health and safety:** the insulating materials used in the panels must not be among those prohibited by current legislation.
- **Microbial growth:** the materials used must not facilitate or constitute a source of food for the development of microbes, as demonstrated by standardized tests, including after cleaning simulations.

- **Water vapor resistance:** water vapor resistance must not be less than $140 \text{ m}^2 \times \text{h} \times \text{Pa}/\text{mg}$ for the external cladding to prevent condensation inside the ducts, with tests in accordance with UNI EN 12086.
- **Dimensional stability under temperature and humidity conditions:** dimensional changes must be less than $\pm 2\%$ in length, $\pm 1.5\%$ in width, and $\pm 0.5\%$ in thickness under conditions of $70 \text{ }^\circ\text{C}$ temperature and 90% relative humidity for 48 hours, as per standardized tests.
- **Weighted sound absorption:** The weighted sound absorption class of the panel (α_w) must be determined and declared in accordance with EN ISO 11654 (Table B.1).
- **Thermal properties:** Thermal conductivity and thermal resistance must be based on measurements carried out in accordance with UNI EN 12667 or UNI EN 12939 and following the specific product standards relating to the insulation used.
- **Fire reaction:** fire classification (Euroclass) must be determined in accordance with EN 13501-1.
- **Mechanical properties:** the stiffness of the panel measured by means of a bending test obtained by holding a panel at 1.0 m without supports and free to bend under the effect of its own weight is relevant.
- **Facilities for cleaning:** the ductwork shall conform to the requirements specified in ENV 12097. The Isocanale ductboard resists the cleaning operations equivalent to a life span of 20 years of use without any damage, the material from the inside surface of the ductwork doesn't break away, flake off, and show evidence of delamination and erosion.



Panel rigidity test image

Examples of requirements for pre-insulated ducts and insulating panels are given in the product classes chapter.

1.4 Sustainability

Compliance with Italian Minimum Environmental Criteria (Criteri Ambientali Minimi CAM)

The measurement and validation of the environmental sustainability of products is a key requirement in public procurement processes, as defined by the Italian National Action Plan on Green Public Procurement (PANGPP) and the Minimum Environmental Criteria (Criteri Ambientali Minimi CAM) implemented by Ministerial Decree of June 23, 2022 and more recently by Ministerial Decree of November 24, 2025.

Pre-insulated aluminum ducts meet the requirements specified in relation to recycled material content and the absence of hazardous substances. The recycled content is declared through certifications issued by third parties. The absence of substances hazardous to humans and the environment is declared by the manufacturer through the safety data sheet.

Examples of third-party compliance with recycled content:



Examples of voluntary safety data sheets:

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STIFERITE PRODUCT SAFETY INFORMATION Pag. 1/5

Regulation (EC) no. 1907/2006 of the European Parliament and of the Council, and subsequent updates, provides for the drafting of the Safety Data Sheets (SDS) for substances and mixtures/preparations classified as dangerous.

Stiferite insulation boards are considered articles under the Regulation, this Product Safety Information Sheet has been prepared to reflect the primary SDS requirements as set out in Annex II to Regulation (EC) No 1907/2006 (REACH), and amended by Commission Regulation (EU) No 2015/830 as they might reasonably apply to articles.

The sole purpose of this information sheet is to provide additional information.

1. IDENTIFICATION OF THE PRODUCTS AND COMPANY

The voluntary safety data sheet refers to the following **ISOCANALE STIFERITE** products:

• A6B	• AHH	• AL8
• AAB	• AHL	• ALC
• AAL	• AI2	• ALE
• AB8	• AI4	• AL
• AC8	• AI6	• LB3
• AEB	• AI8	• LB4
• AHB	• AIG	• LB4
• AHG		

Relevant identified uses: Thermal insulation products for buildings

Details of the Supplier of the Product Safety Information Sheet:

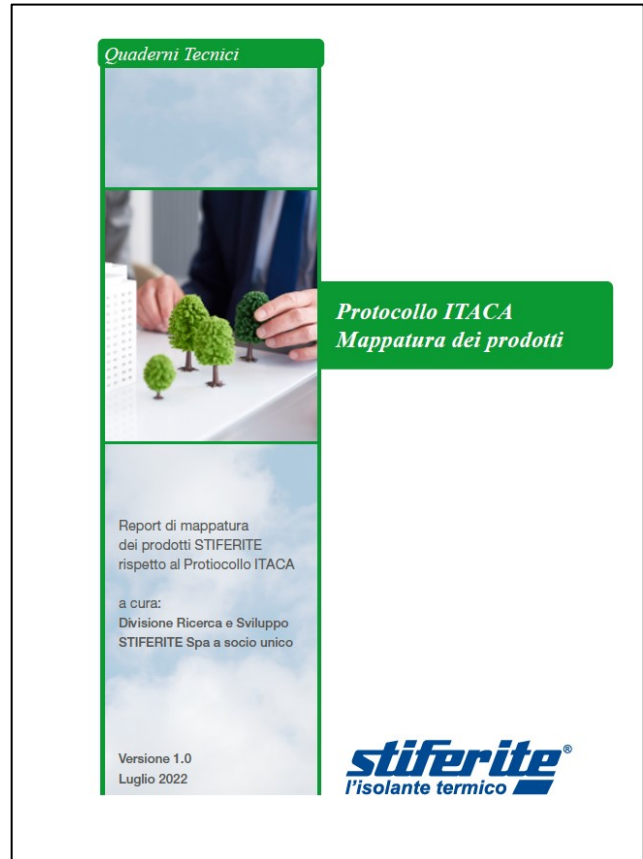
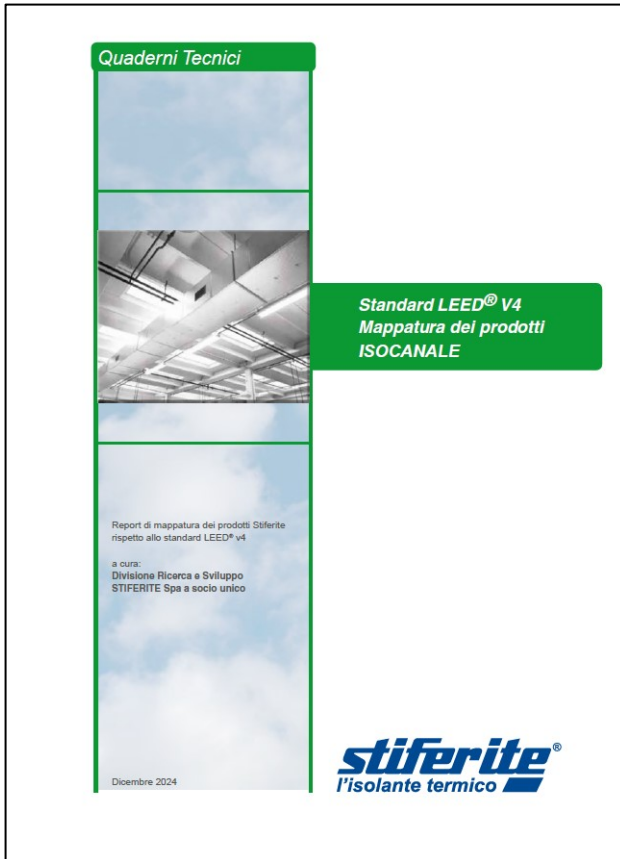
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Voluntary environmental sustainability certifications

The sustainability requirements of a building from an environmental, social, economic, and health perspective can be assessed through voluntary certification protocols such as LEED and ITACA.

Within these protocols, pre-insulated aluminum ducts are normally assessed in terms of thermal insulation and system efficiency, as well as from the point of view of air quality and VOC emissions.

Examples of product mapping for the construction of ducts in LEED and ITACA certified buildings:



1.5 Acoustic insulation

The noise emitted by an HVAC system in living spaces must not exceed specific limit values.

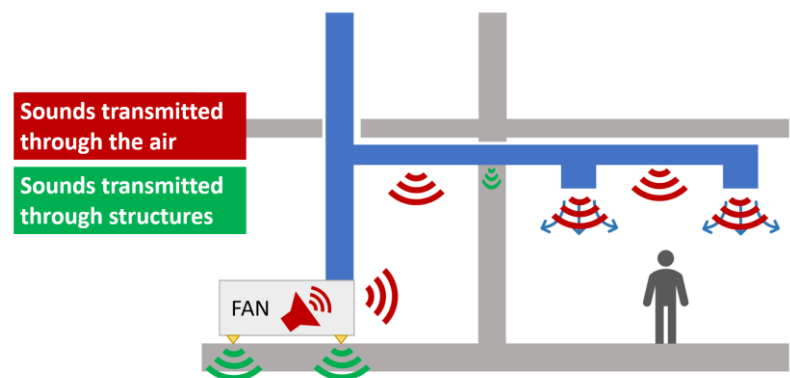
These values are defined by current Italian legislation (e.g., Prime Ministerial Decree 5/12/1997 and Minimum Environmental Criteria Decree 2024) and by any requests made by the client.

Some Italian technical standards propose maximum noise levels that must not be exceeded. For example, guidelines can be found in:

- UNI 11532-2: Internal acoustic characteristics of confined spaces - School sector
- UNI 11367: Acoustic classification of building units
- UNI EN 16798-1: Ventilation for buildings - Design parameters in relation to air quality, thermal environment, lighting, and acoustics
- UNI ISO 22955: Acoustic quality of open office spaces
- UNI EN ISO 3382-3: Measurement of acoustic parameters of rooms - Part 3: Open plan

In a very short statement, the noise generated by a ventilation unit (FAN) propagates through the air via the intake and exhaust ducts.

It can be radiated into the living environment at the air vents and along the ducts. In addition, the ventilation system can transmit vibrations and noise to building structures at rigid contacts.

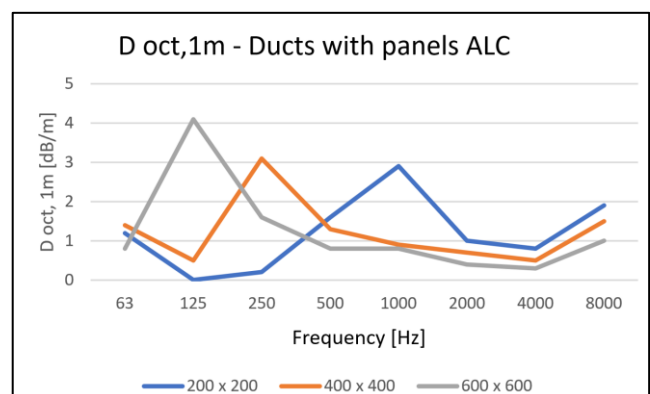


A first strategy to reduce system noise consists of using ventilation units with adequate sound power levels, located in technical rooms far from living areas and connected to the building structures by means of anti-vibration joints.

To limit the propagation of sound along the ducts, silencers or pre-insulated ducts can be installed to attenuate noise along the route. The performance of these systems can be measured in the laboratory in accordance with the UNI EN ISO 7235 standard.

Stiferite has carried out laboratory tests, in accordance with ISO 7235, to evaluate the insertion losses of its pre-insulated ducts measured as the difference (D) between the noise level transmitted by a pre-insulated duct and the level transmitted by a duct of similar shape made of steel.

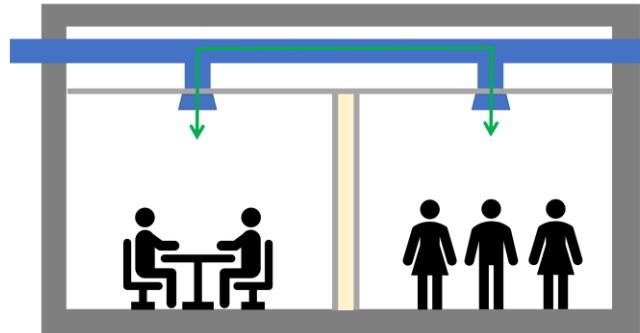
Performance varies depending on the characteristics of the duct and its cross-sectional dimensions. The graph on the right shows, for example, that one meter of pre-insulated duct, made with “ALC” panels and with a cross-section of 200x200 mm, results in a peak reduction of approximately 3 dB at a frequency band of 1000 Hz. The same duct with a cross-section of 600x600 mm shifts the peak sound insulation to 125 Hz.



Another strategy for reducing noise propagation consists of distributing the sound along different paths, using plenums, for example. Furthermore, to prevent sounds from being radiated from the ducts into the living environment, it is possible to:

- use ducts with adequate soundproofing performance
- shield the ducts with soundproofing elements (e.g., false ceilings).

Finally, it should be noted that ventilation ducts can become sound transmission paths between different living spaces.



This problem can be handled by:

- using systems with adequate sound absorption and sound insulation properties,
- using different ducts for different rooms,
- installing “plenum boxes” at the ventilation outlets.



Duct with silencing boxes

1.6 Fire prevention

The proper design and construction of an air duct, in relation to fire prevention, requires, for each project, a designer with in-depth knowledge of the laws in force to be applied according to the intended use of the building and the activity involved.

Building safety is an essential requirement in Italy under **Construction Products Regulation 305/2011** and CPR Regulation 3110/2024, which applies to individual materials and technological solutions in real-world conditions of use. In the field of safety, fire prevention is of particular importance; to meet this requirement, active and passive fire prevention strategies can be identified. Passive systems concern the set of design and construction solutions and the choice of materials that limit the development of a fire and the damage caused by its spread.

Fire prevention laws, whether they are performance-based (e.g., Fire Prevention Code DM August 3, 2015, and subsequent amendments) or traditional prescriptive laws such as decrees for specific activities subject to fire prevention (Presidential Decree 151/2011), establish minimum limits for reaction to fire, assessed as a passive strategy. The fire prevention code, for example, establishes the following fire reaction classes for pre-insulated ventilation and heating ducts (table S.1-8).

Description of materials	GM1		GM2		GM3	
	Ita	EU	Ita	EU	Ita	EU
Pre-insulated ventilation and heating ducts [1]	[na]	B-s2, d0	[na]	B-s2, d0	[na]	B-s3, d0
Fittings and joints for ventilation and heating ducts (L < 1.5 m)	1	B-s1, d0	1	B-s2, d0	2	B-s3, d0
[na] Not applicable [1] The European class B-s2, d0 is only permitted if the insulating component is not directly exposed to flames due to the presence of a layer of non-combustible or class A1 material covering it on all sides, including the longitudinal and transverse interruption points of the duct. Useful references: EN 15423, EN 13403						

Table S.1-8 extract: Classification of materials for installations into groups – Fire prevention code

Fire reaction must therefore comply with national legislation for the specific application. With the publication in Official Gazette no. 251 of October 26, 2022, of the Ministerial Decree of October 14, 2022, the regulations on fire reaction classification and material approval were amended.

Since November 28, 2023, building materials and other materials incorporated into the building, such as ventilation and heating ducts, must undergo classification testing in accordance with the European method (UNI EN 13501-1). Pre-insulated duct solutions with PIR polyurethane foam for air transport and heating currently on the market generally have a classification of B-s2, d0 or B-s1, d0.



1.7 Volatile Organic Compound Emissions - VOC

In addition to the provisions of UNI EN 13403, the measurement and validation of the safety of a construction product is a key requirement in the design of sustainable buildings according to voluntary protocols such as LEED, ITACA, BREEAM, and according to the laws of some European countries where classifications on the emission limits of volatile organic compounds (VOCs) have been published, such as France (Regulation of April and May 2009 DEVP0908633A and DEVP0910046A) and Germany (Ausschuss zur gesundheitlichen Bewertung von Bauprodukten June 2021), according to intended use and application.

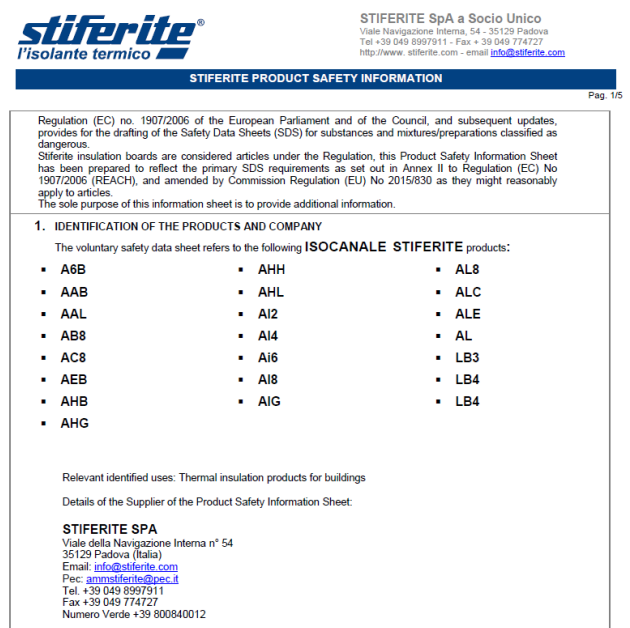
Some certification laboratories specializing in the measurement of volatile organic compounds have also published voluntary protocols for measuring and classifying construction products in accordance with all relevant European laws and building sustainability protocols, such as the Eurofins Indoor Air Comfort Gold label. This label is subject to annual monitoring of the manufacturer by the certification laboratory.

Pre-insulated aluminum ducts meet the specified requirements; the emission of volatile organic compounds is declared through certifications issued by third-party bodies, and the measured values certify the products in the best classes of all European countries that have published on the subject. These values also comply with voluntary building sustainability protocols and, in particular, indoor air quality criteria.

Examples of certification for emissions of volatile organic compounds (VOCs):



Examples of voluntary safety data sheets:



2 THERMAL INSULATION OF DUCTS

2.1 Thermal insulation

Specification of the insulating materials used for pre-insulated ducts is contained in the harmonized standard for CE marking UNI EN 14308:2016 - Thermal insulation products for building systems and industrial installations - Factory-made rigid polyurethane foam (PUR) and polyisocyanurate foam (PIR) products - Specification.

Product standards are harmonized at European level and therefore insulation products are CE marked for marketing.

2.2 The declared thermal conductivity

Thermal insulation is one of the essential requirements set out in the product standard for insulating materials for building systems and industrial installations and the resulting CE marking of the product with a Declaration of Performance (DoP).

The conductivity declared in accordance with UNI EN ISO 10456 is defined as:

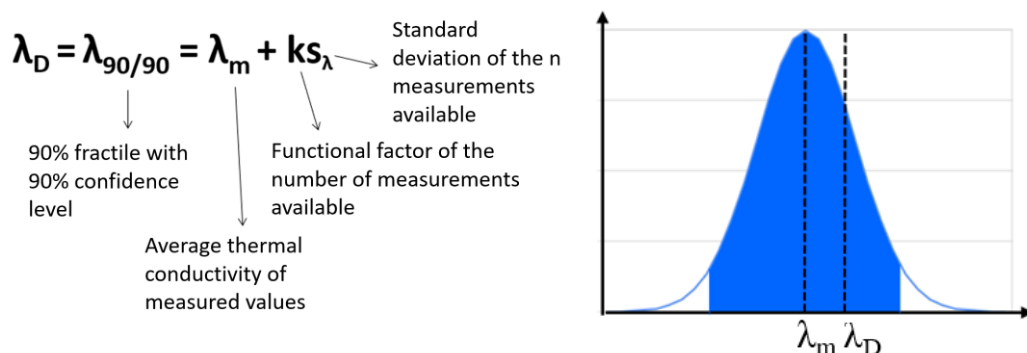
“The thermal conductivity value representative of a given percentage of production and with a given level of confidence. The value is derived from a series of measurements taken under standard temperature and humidity conditions and corresponds to a reasonably expected performance level for the product's service life under normal operating conditions.”.

When this value represents 90% of production with 90% confidence, conductivity is also referred to as $\lambda_{90/90}$.

The thermal conductivity values declared under the company's responsibility are derived from characterization tests that are consistent over time and carried out by a third party.

The declared conductivity λ_D , as required by the CE marking, allows:

- 1) comparison between products, as they are tested and seasoned under the same conditions for at least 25 years;
- 2) guarantee that the panels perform as declared when installed.



Representation of the formula for calculating λ_D as $\lambda_{90/90}$, starting from the average conductivity λ_m and the statistical analysis factors k and s_λ .

2.3 The linear dispersion coefficient

It is possible to evaluate the effectiveness of the thermal insulation in the product by knowing the thickness of the insulating material and its declared conductivity.

The thermal insulation of air ducts has two main purposes: energy saving and condensation risk control. The latter is discussed in a later chapter.

The energy savings resulting from the use of thermally insulated ducts are linked to the amount of energy dispersed through the surface of the duct and therefore to its cross-section, as well as to the thermal insulation.

For example, a rectangular air duct with internal dimensions of 250 x 500 mm (with air flow rate $V = 2000 \text{ m}^3/\text{h}$) behaves differently depending on the degree of thermal insulation:

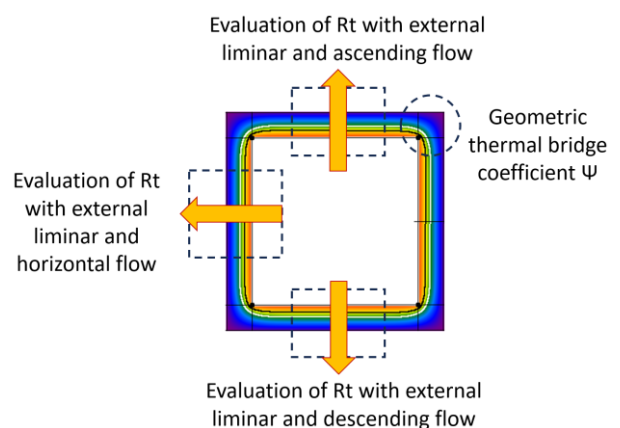
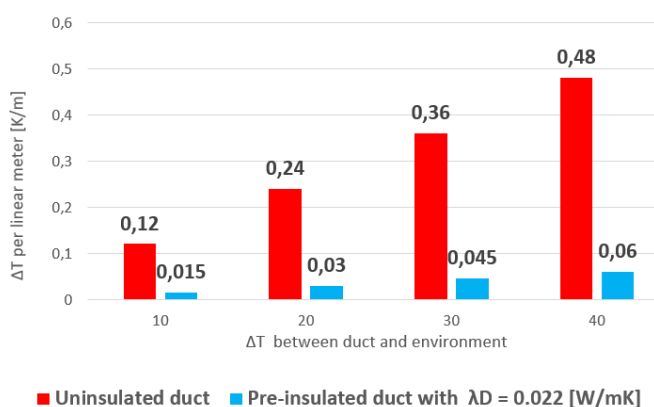
ΔT [K] between channel and environment	Temperature reduction per linear meter of duct [K/m]	
	Uninsulated duct	Pre-insulated duct with $\lambda_D = 0,022 \text{ [W/mK]}$
		22 mm
10	0,12	0,015
20	0,24	0,030
30	0,36	0,045
40	0,48	0,060

Elaboration of the temperature reduction table. Source [6]

The importance of thermal insulation is evident, as it allows for savings of at least one order of magnitude in the amount of energy lost.

The channel can also be characterized by a linear dispersion coefficient that depends on its size and degree of insulation, through which it is possible to estimate energy loss.

To evaluate the linear coefficient, it is necessary to study the behavior of the duct section with assessments similar to those of a wall or roof structure with unidirectional flow, adding the two-dimensional behavior of the corners.



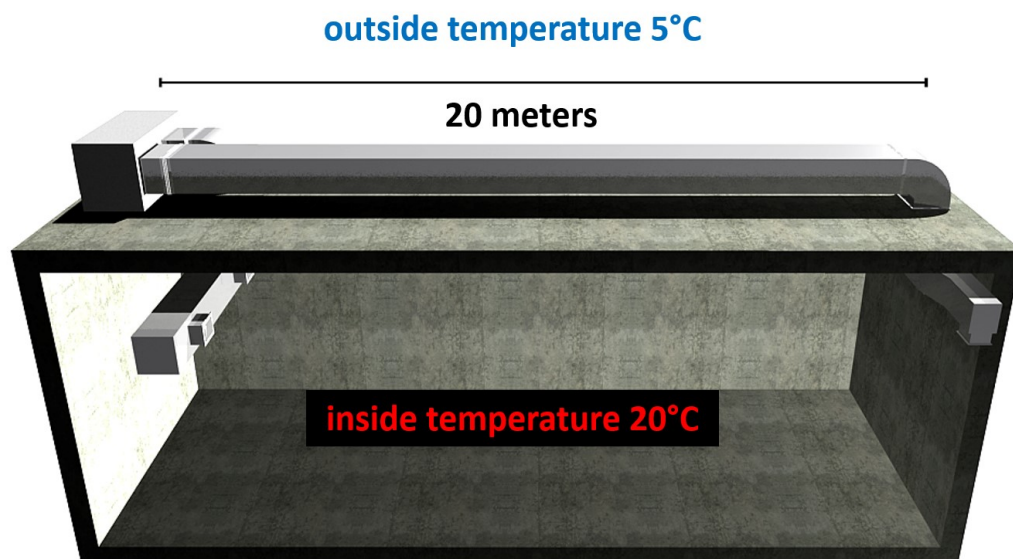
Temperature reduction per linear meter of duct [K/m as the temperature difference between the air in the duct and the outside environment varies]

Diagram showing the evaluation of the linear heat transfer coefficient of an insulated air duct


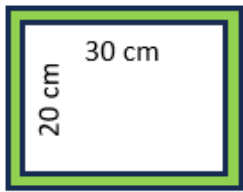
Evaluation example

The following example highlights the difference in energy loss between an uninsulated duct and a pre-insulated duct with the same internal cross-section of 20 cm x 30 cm and a length of 20 meters.

The duct is designed to carry air at a temperature of 30 °C through an unheated room with a temperature of 5 °C. The difference in air temperature inside the duct and outside the room generates heat migration, which is counteracted by the degree of insulation of the duct. In order to estimate this dispersion, it is necessary to evaluate the linear exchange coefficient W/mK of the two ducts.



For the uninsulated duct, this value is 6.11 W/mK, while for the insulated duct (e.g., Isocanale ALC), it is 0.62 W/mK. Since steady-state heat loss is proportional to the temperature difference and the heat transfer coefficient, it is clear that the pre-insulated duct will lose 1/10 of the heat lost by the uninsulated duct. Below are some significant data and the complete steps.

	Uninsulated duct	Pre-insulated duct with 3 cm of PIR (e.g. - Isocanale ALC)
		
Linear heat exchange coefficient	6.60 W/mK	0.69 W/mK
Duct length	20 m	20 m
Internal air temperature	30 °C	30 °C
Power loss	3030 W	347 W

Detailed evaluation

Geometric dimensions

Height	h	[m]	
Width	L	[m]	
Perimeter	2P	[m]	
Heat loss surface per meter of depth	A	[m ²]	
Liminar resistances			
Upward flow	R _{se}	m ² K/W	
Downward flow	R _{se}	m ² K/W	
Horizontal flow	R _{se}	m ² K/W	

internal	external
0,20	0,20
0,30	0,30
1,00	1,01
1,00	1,01

0,043	0,122
0,043	0,122
0,043	0,122

Insulating material			
Thickness	s	[m]	0,002
Thermal conductivity	λ _D	[W/mK]	100

Overall thermal resistance	R _t	m ² K/W	0,17	
Transmittance	U	W/m ² K	6,060	
Heat loss coefficient	H	W/K	6,06	6,11
Linear coefficient PT angle	ψ	W/mK	0,0	0
Linear heat exchange coefficient	L2d	W/mK	6,06	6,11

Air duct length	L	m	20,0
Internal temperature	°C		30,0
External temperature	°C		5,0
Power loss	W		3030

Geometric dimensions

Height	h	[m]	
Width	L	[m]	
Perimeter	2P	[m]	
Heat loss surface per meter of depth	A	[m ²]	
Liminar resistances			
Upward flow	R _{se}	m ² K/W	
Downward flow	R _{se}	m ² K/W	
Horizontal flow	R _{se}	m ² K/W	

internal	external
0,20	0,23
0,30	0,33
1,00	1,12
1,00	1,12

0,043	0,122
0,043	0,122
0,043	0,122

Insulating material			
Thickness	s	[m]	0,030
Thermal conductivity	λ _D	[W/mK]	0,022

Overall thermal resistance	R _t	m ² K/W	1,53	
Transmittance	U	W/m ² K	0,654	
Heat loss coefficient	H	W/K	0,65	0,73
Linear coefficient PT angle	ψ	W/mK	0,010	-0,029
Linear heat exchange coefficient	L2d	W/mK	0,69	0,62

Air duct length	L	m	20,0
Internal temperature	°C		30,0
External temperature	°C		5,0
Power loss	W		347

Uninsulated rectangular duct

Insulated rectangular duct
(e.g. - Isocanale ALC)

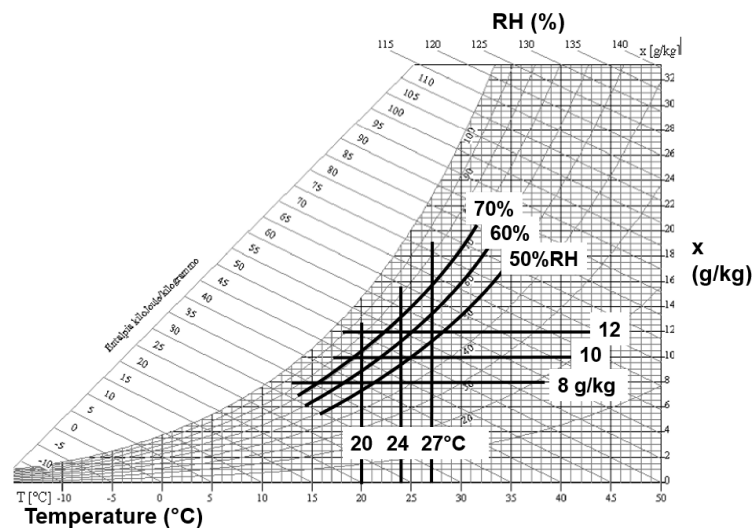
3 CONDENSATION

Thermal insulation of ducts is a means of avoiding the risks associated with surface condensation caused by humid air. This chapter describes how to use the psychrometric chart and how to assess and control condensation risks in ducts.

3.1 Psychrometric chart

The psychrometric chart is a very useful tool for representing the air conditions in an environment and assessing condensation conditions. This chart was created from the idea of correlating variables such as relative humidity (RH), absolute humidity (x), and temperature (T) for air on a graph. For each temperature level, the air can store up to a maximum (well-known) amount of air humidity in the form of vapor before condensing. By constructing a graph with this information, we obtain the saturation curve.

The psychrometric chart is the tool that extends this correlation by linking temperature and absolute humidity for all saturation percentages, as shown in the figure.

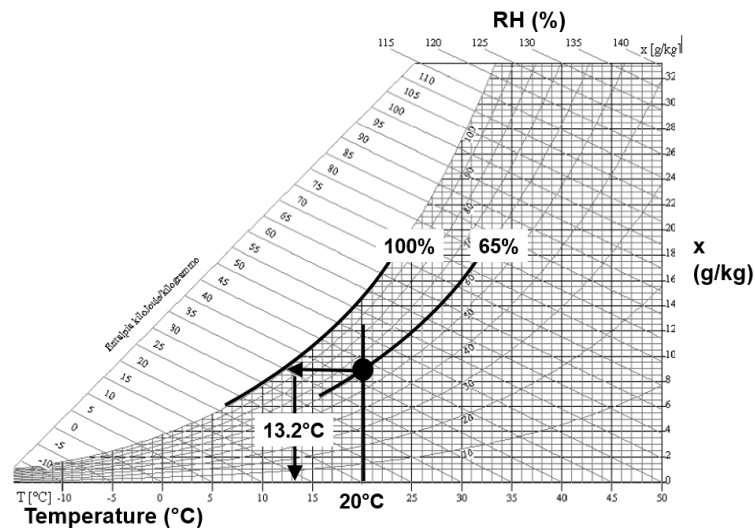


The psychrometric chart relates temperature, absolute humidity, and relative humidity for air.

The psychrometric chart shows temperature ($^{\circ}\text{C}$) on the horizontal axis, absolute vapor content x (g/kg) on the vertical axis, and relative humidity levels RH (%) on the curves. Thanks to the psychrometric chart, it is always possible to derive one of the three variables from the other two.

The dew point temperature

A second useful information that can be obtained from the chart concerns the dew point temperature. Starting from any initial condition (e.g., RH=65% and T=20°C), information about the dew point (or condensation) temperature can be obtained by moving horizontally to the left on the diagram until the 100% curve (saturation curve) is crossed. The corresponding value on the horizontal axis represents the dew point temperature, in this case 13.2°C.

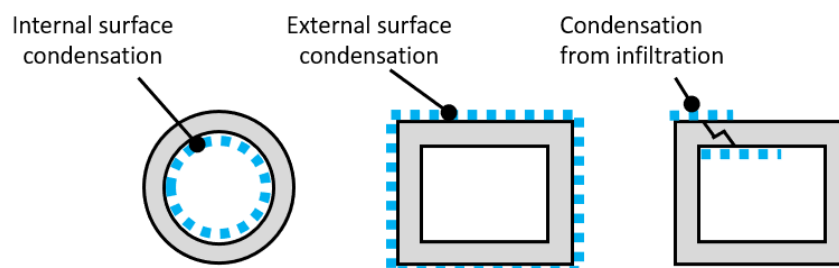


From the chart, it is possible to obtain the dew point temperature based on air conditions and the saturation curve.

3.2 Risk of condensation

Since the air inside the ducts can have temperatures that differ significantly from those of the surrounding environment, the risk of condensation can occur in the following ways:

- **Internal surface condensation:** if the air in the environment surrounding the duct contains a high level of humidity and the internal surface of the duct is below the dew point, there is a high risk of internal surface condensation.
- **External surface condensation:** if the internal air has a lower temperature than the external temperature and the duct wall is not sufficiently insulated, the water vapor present in the surrounding environment can condense on the external surface of the duct.
- **Condensation from infiltration:** due to the diffusion of vapor inside the duct wall itself.



Special attention must be paid to the consequences of condensation and, in particular, to the possible corrosion of the metal used to construct the pipe itself. Water is also a thermal conductor, so special attention must also be paid to the loss of insulating properties.

3.3 Control of condensation problems

Internal surface condensation

The UNI EN 13403 standard “Ventilation for buildings - Non-metallic ducts, ductwork made of insulating material” stipulates that the water vapor resistance of the wall in the ducts must not be less than 140 m²hPa/mg for the external coating, in order to avoid the risk of internal surface condensation.

This value is widely verified for a pre-insulated duct made with an aluminum coating at least 60 micrometers thick, such as the Stiferite Al6 product.

The correct installation of the ducts is particularly important. Incorrect sealing of the various elements, or at the insertion points of special pieces, can cause ambient air to enter the duct.

External surface condensation

This problem can occur in ducts that carry cold air. To prevent condensation on the external surface, the thickness of the wall insulation must be correctly dimensioned in order to maintain the external surface temperature above the dew point under the conditions present in the ambient air.

The calculation method is that specified in the UNI EN ISO 12241 standard. Knowing the thermal conductivity of the material constituting the duct wall, it is possible to determine the minimum thickness required.

The formula for determining the minimum resistance of the duct wall, valid for an external temperature greater than 0 °C, is as follows:

$$R \geq \frac{R_{se}(T_a - T_i)}{T_a - \frac{237,3 \ln \frac{p_a}{610,5}}{17,269 - \ln \frac{p_a}{610,5}}} - R_{se} - R_{si}$$

Where:

R_{se} (m²K/W) is the external surface resistance of the duct wall

R_{si} (m²K/W) is the internal surface resistance of the duct wall

T_a (°C) is the ambient temperature

T_i (°C) is the temperature inside the duct

p_a (Pa) is the vapor pressure in the environment (obtainable with the UNI EN ISO 13788 standard)

Calculation example

$T_a = 28^\circ\text{C}$

RH= 70%

These conditions correspond to a vapor pressure of 2640 Pa.

$R_{se} = 0,25$ (value indicated by UNI EN ISO 13788 for lightweight structures)

$R_{si} = 0$ (resistance can be neglected according to the indications of standard UNIEN ISO 12441)

$T_i = 8^\circ\text{C}$

Under these conditions, the result is:

$R \geq 0,581$

The conductivity of the insulating material constituting the wall (polyurethane) is $\lambda_D = 0.022$ W/mK (product example – Isocanale ALC).

S (insulating material thickness) = $R \cdot \lambda_D = 0,013$ m

The minimum thickness to avoid the risk of condensation is therefore 13 mm. The minimum installation thickness of polyurethane duct (20 mm) is therefore more than sufficient to prevent this problem and also protect the metal of the panel from the risk of corrosion.

A channel without thermal insulation cannot be used for this application.

Condensation from infiltration

This is an extremely rare phenomenon, as the ducts are usually lined with metal material that acts as a vapor barrier, thus preventing the diffusion of vapor into the wall thickness. In addition, at points of discontinuity, such as joints, appropriate sealants are used to ensure the system's tightness class and prevent condensation.

If you wish to carry out an assessment under specific conditions, you can use the method described in the UNI EN ISO 13788 standard for pre-insulated ducts.

Isocanale Stiferite products with an aluminum thickness of at least 60 micrometers are suitable for preventing the risk of water infiltration.

Any pre-insulated ducts with micro-perforated metal cladding may be at risk of condensation from infiltration.

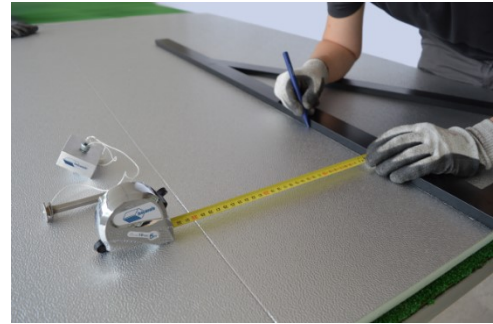
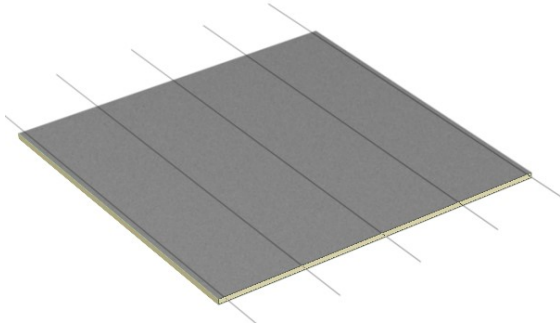


4 TECHNOLOGY SOLUTIONS

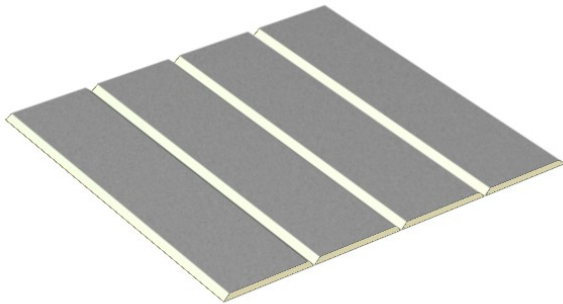
4.1 Assembly of the duct

Creating a duct from a polyurethane panel is a simple operation that involves the following steps.

The first step is to draw the reference lines that will be used to make the cuts on the insulation panel.



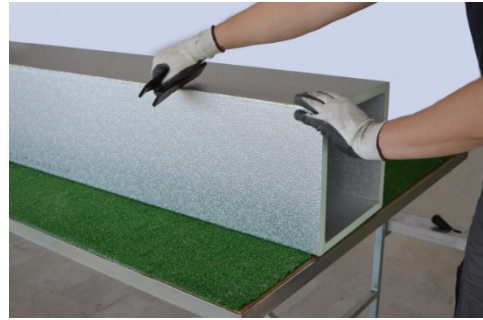
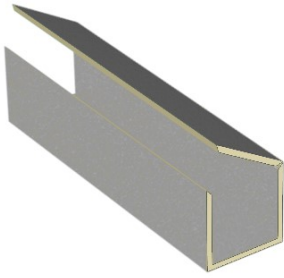
Use the appropriate planes to engrave the panel and create the grooves.



Apply polyurethane foam glue to the grooves.



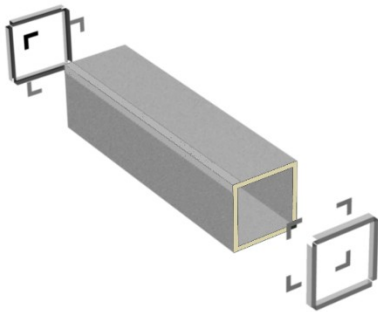
Fold the panel, joining the shaped edges, to create the channel.



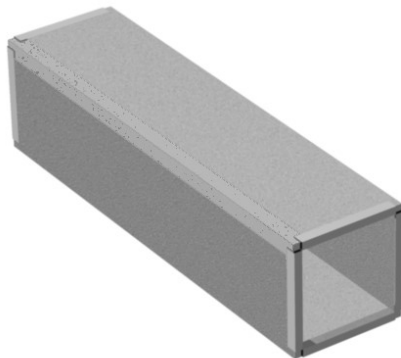
Use the special rigid spatula to press down on the glued edges so that the glue adheres properly. Using the tape marker and the soft spatula, apply the aluminum tape to the edge created by the sides of the channel.



At the channel openings, apply the metal profiles complete with reinforcement brackets, specific to the chosen connection system. Everything will be glued with the appropriate profile adhesive.

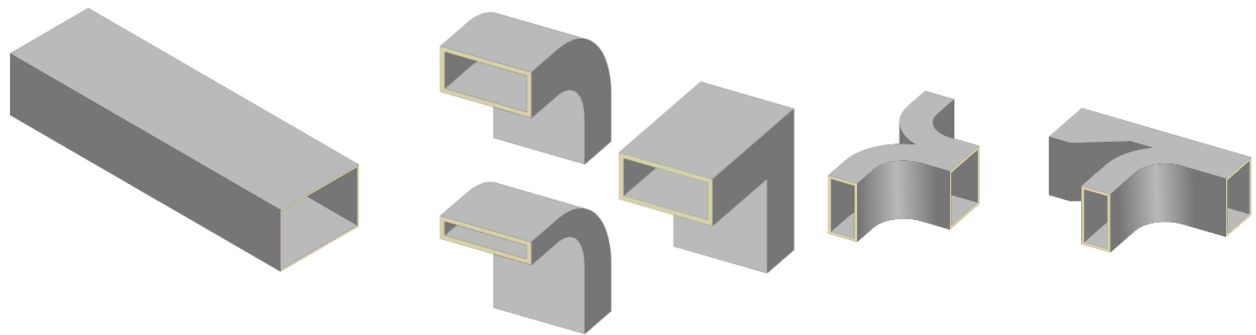


Finally, apply silicone along the inner edges of the channel.



Ventilation and heating ducts come in different shapes, sizes, and geometries, making it possible to develop air distribution networks inside buildings.

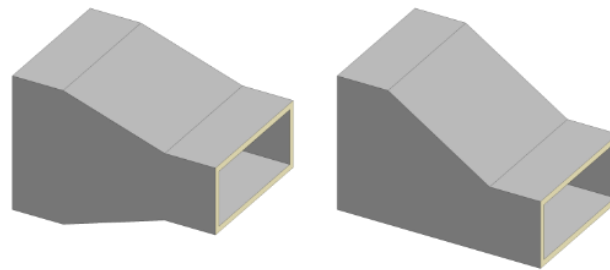
The components of the air distribution network are:



straight channels

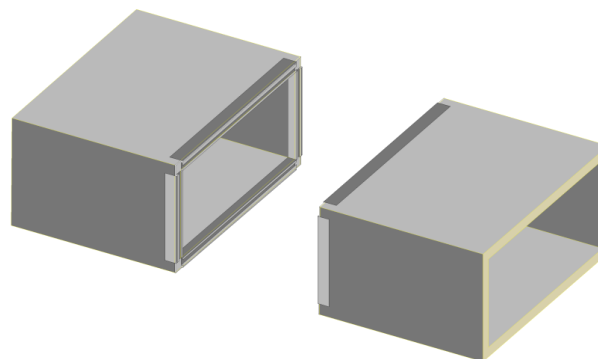
symmetrical, asymmetrical,
and 90° bends with deflectors

2-, 3-, or 4-way deviations



symmetrical and asymmetrical reductions

For the construction of air ducts, accessories are used to connect the various parts of the ducts to each other, including the connection of the ducts to the AHUs or dampers (fire dampers or flow control dampers), the reinforcement of the ducts near areas with higher pressure/lower pressure, and the connection to the diffusers and air outlets.



profiles for connecting ducts

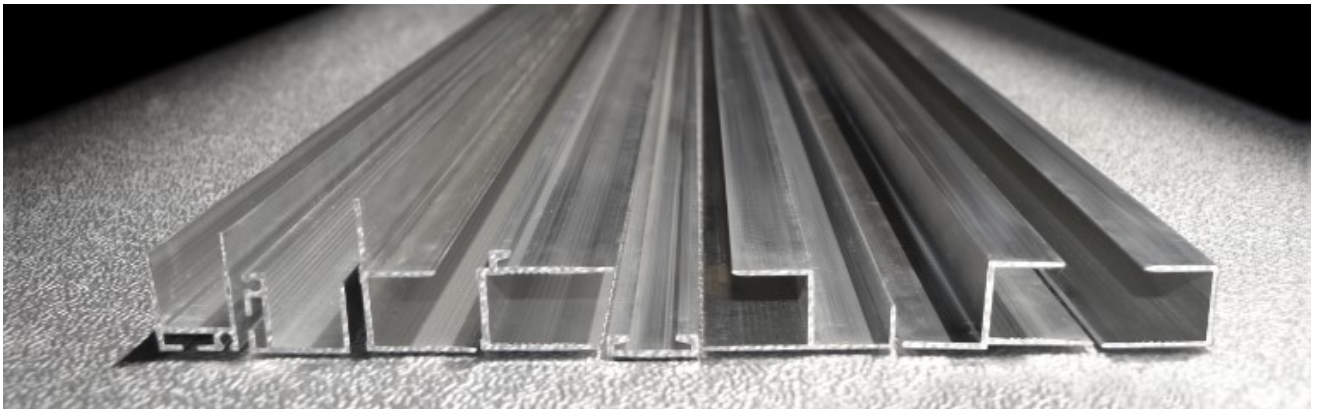
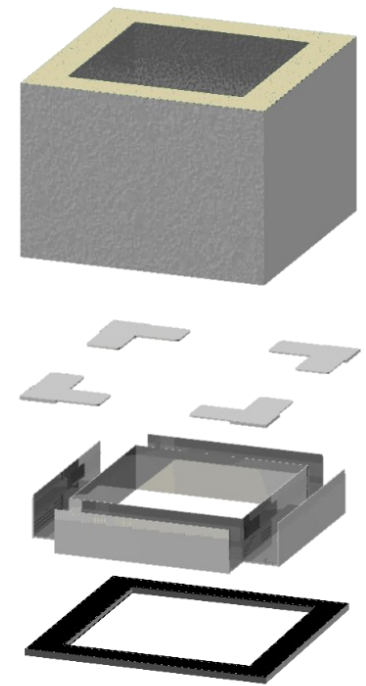
The connections are made using profiles, reinforcement angles, gaskets, and fastening systems.

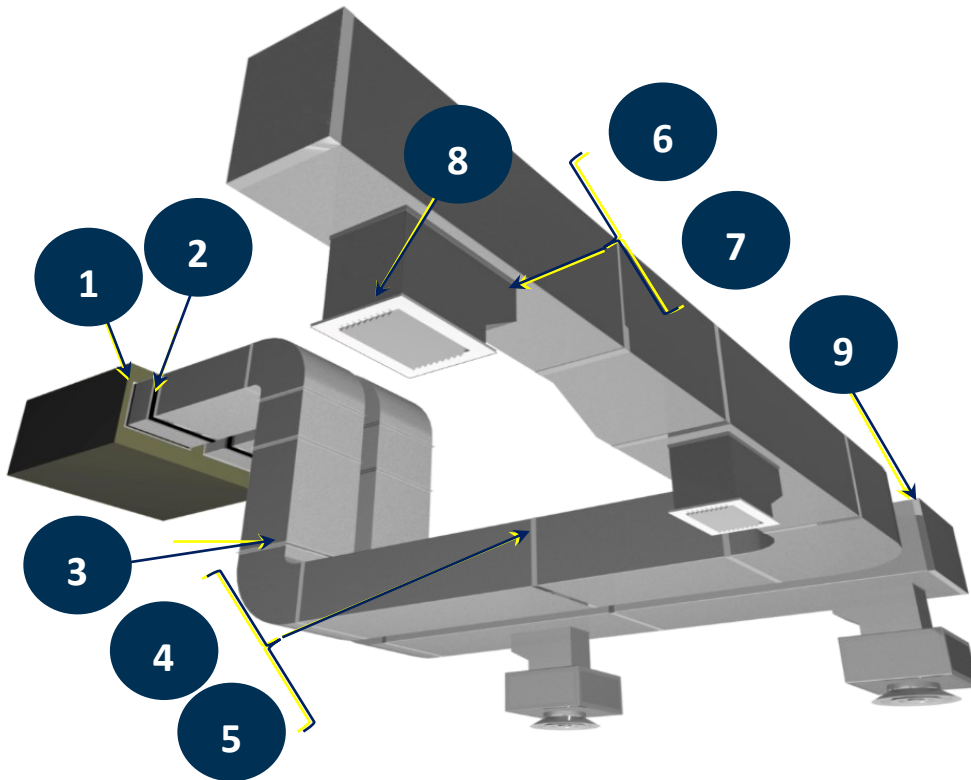
The angles give rigidity to the duct openings to ensure their rectangular section and pressure tightness.

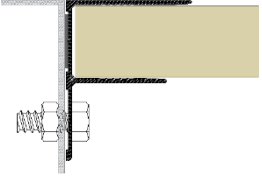
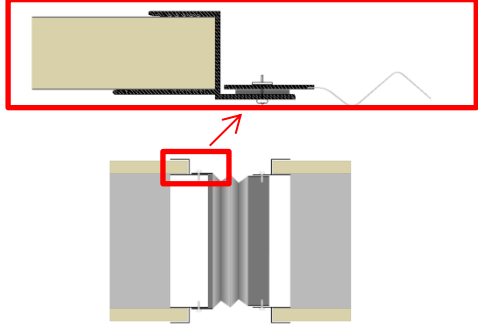
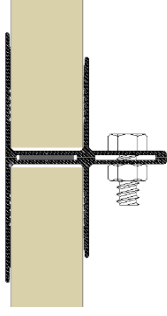
The profiles, of various sections, allow the duct sections to be connected to each other or to other elements of the air duct network.

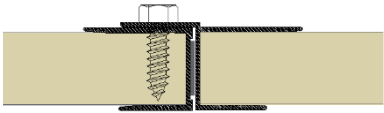

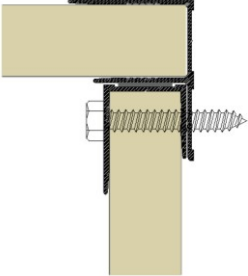
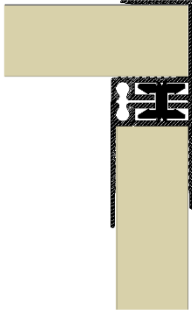
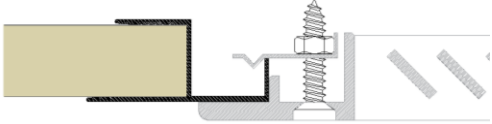
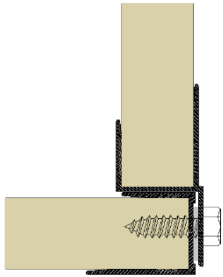
The gaskets ensure the pneumatic tightness of the system.

Depending on the complementary elements chosen to complete the air treatment system, various connection profiles can be used.





<p>1</p>	<p>AHU channel connection: an “H” or “F” shaped connection profile is used, plus an adhesive gasket. The choice of profile depends on the shape of the AHU inlet.</p>	
<p>2</p>	<p>Anti-vibration joint for connection between AHU and pre-insulated duct: this is a connection system that prevents the direct transmission of vibrations between the air handling unit and the duct network thanks to a PVC gasket.</p>	
<p>3</p>	<p>F-shaped connection, useful for creating anchors for vertical channels by fixing the profiles to special support brackets and for creating removable channel sections, if necessary. The F-shaped profile also allows connections with flat surfaces (see point 1).</p>	

4	<p>“h+u” connection; this is a connection system between sections of ducts. It requires an adhesive seal and self-tapping screws.</p>	
5	<p>Invisible flange connection: this is a system for connecting sections of ducts using identical profiles and a concealed PVC bayonet fitting that provides a rigid connection and pneumatic seal.</p>	
6	<p>Connections for disconnections with “F+u” profiles. Requires an adhesive gasket and self-drilling screws.</p>	
7	<p>Connection for disconnections with retractable PVC bayonet coupling providing rigid connection and pneumatic seal.</p>	
8	<p>Profiles for diffusers; they allow the air diffusion diffusers to be anchored to the duct or to plenum boxes made with pre-insulated panels.</p>	
9	<p>Caps: closure system to be placed at the end of the duct. It can be inspectable or fixed depending on the maintenance and cleaning plan for the air duct network.</p>	

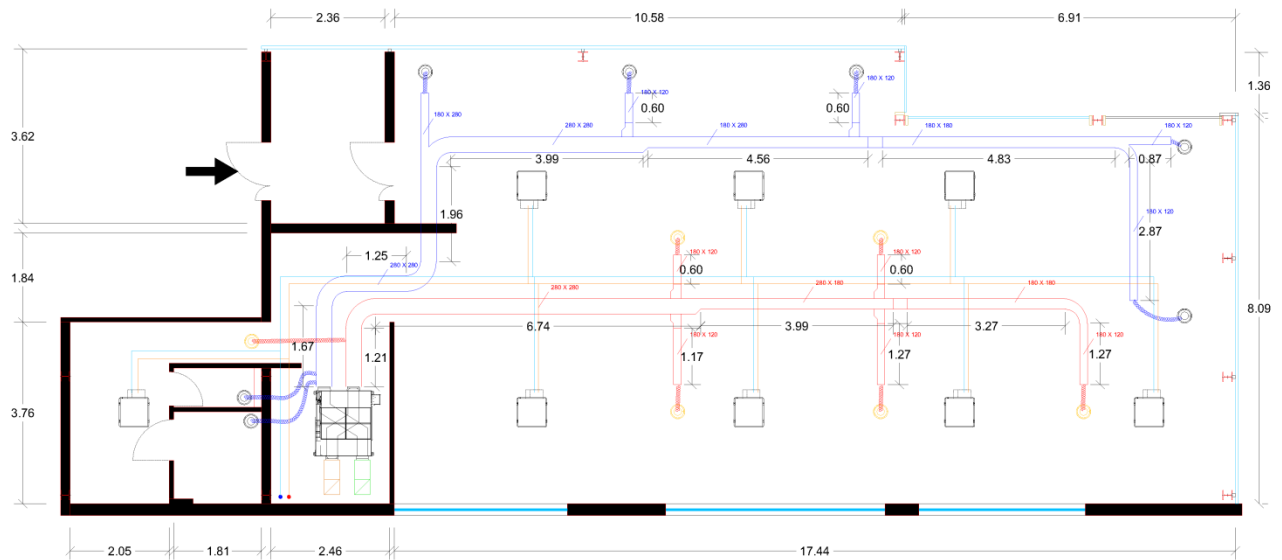
EXAMPLE OF COMPONENT CALCULATION

The creation of an air handling system begins with the design carried out by specialized technicians who, starting from the geometry of the building in which the system will be located and passing through the thermotechnical criteria to be met depending on the intended use, create a layout consisting of air handling machines and system distribution diagrams.

Based on these designs, i.e., the architectural drawings and linear diagrams, the technicians convey the characteristics of the finished system to the installers.

The architectural drawings can be used to evaluate the development of the duct distribution network, obtaining information related to the duct cross-section, their length, and the dimensions to be respected in order to route them between different rooms or between the various floors of the building.

With this data, it is possible to obtain a precise assessment of the materials needed to carry out the project.



In this example, we consider a building for tertiary use, with a usable area of 185 m² and a volume of approximately 555 m³; the air conditioning system consists of ceiling-mounted fan coil units and air exchange is managed by a controlled mechanical ventilation system. The pre-insulated variable section air ducts are connected to the ventilation and heat recovery units.

The ducts, divided into two lines (supply and return), are quantified in the following diagram.

List of components required to build the duct system shown in the example:

Namee	# pieces	Duct type	Panel thickness mm	base cm	height cm	Length cm	Panels m ²
Supply and Return	1	Straight channel	20	280	280	2000	2.56
Supply and Return	1	Straight channel	20	280	280	2000	2.56
Supply and Return	4	Deflector	20	280	280		1.64
intake	1	Straight channel	20	280	280	1670	2.14
intake	2	Deflector	20	280	280		1.64
intake	1	Straight channel	20	280	280	1250	1.6
intake	1	Straight channel	20	280	280	1960	2.51
intake	1	Straight and curved channel bifurcation	20	280	280		2.64
intake	1	Reduction	20	280	280		0.67
intake	1	Straight channel	20	180	280	4560	4.92
intake	1	Reduction	20	280	180		0.52
intake	1	Straight and curved channel bifurcation	20	180	180		1.53
intake	1	Straight channel	20	180	120	870	0.66
intake	1	Straight channel	20	180	120	2870	2.18
intake	2	Breakaway	20	180	120		0.48
intake	2	Straight channel	20	180	120	600	0.46
intake	5	Caps	20	180	120		0.035
expulsion	1	Straight channel	20	280	280	1210	1.55
expulsion	1	Deflector	20	280	280		1.64
expulsion	1	Straight channel	20	280	280	6740	8.62
expulsion	1	Reduction	20	280	280		0.67
expulsion	1	Straight channel	20	280	180	4000	4.32
expulsion	1	Reduction	20	280	180		0.52
expulsion	1	Asymmetric Deflector	20	180	180		0.75
expulsion	1	Straight channel	20	120	180	1270	0.97
expulsion	4	Breakaway	20	120	180		0.49
expulsion	2	Straight channel	20	120	180	600	0.46
expulsion	1	Straight channel	20	120	180	1270	0.97
expulsion	1	Straight channel	20	120	180	1170	0.89
expulsion	5	Caps	20	120	180		0.036
expulsion	4	Anti-vibration joint	20	280	280		
expulsion	13	Aluminum collars Ø160 mm	20	160			

List of quantities of material required to build the channel system shown in the example with RETRACTABLE BAYONET solution:

Product Code	ALC20	700106	700109	700112	700123	700153	700158	700223
	Pre-insulated panel 1200 x 4000 sp. 20 mm	Panel adhesive [Can 4 Kg]	Glue for profiles [bottles of 500 g]	Aluminum tape [rolls of 50 m]	Neutral gray silicone (cartridges of 300 cc)	Double nylon corner for profiles "h"	Galvanized reinforcement bracket 20 mm	"h" Profile 20 mm
Q Calc	60,3	0,81	0,30	2,24	5,28	72	400	15,71
Q min	96,0	1	1	3	6	72	400	16
Q UV	96,0	1	1	3	6	72	400	16
UM UV	m ²	kg	pz	pz	pz	pz	pz	mt

Product Code	700233	700238	700700	700155	700224	700227	700165
	Anti-vibration gasket 1x160 mm 25 m	Adhesive gasket 15x5 mm 20 m	H-shaped PVC bayonet	PVC corner cover 20 mm	"U" Profile 20 mm	Invisible flange profile 20 mm	Aluminum collars Ø160 mm
Q Calc	0,30	0,58	36,96	200	6,30	74,32	13
Q min	1	1	40	200	8	76	13
Q UV	1	1	40	200	8	76	13
UM UV	pz	pz	mt	pz	mt	mt	pz

With careful planning, the quantification of what is needed to build the ducts is extremely accurate; the use of BIM systems guarantees a very high level of precision. In the event of design oversights, the adaptability of pre-insulated ducts also allows for quick changes during installation with work that can be carried out directly on site.

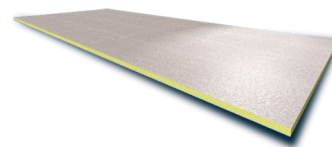
4.2 Product classes

Based on the performance requirements and areas of application described above, there are various types of materials used for the construction of air ducts available on the market.

The intended use affects the choice of product type. Products are distinguished by the density of the polyurethane foam and the type of coating (thickness and characteristics).

Applications in civil, commercial, and industrial buildings

To create air ducts that guarantee maximum versatility of application and long-lasting performance in public or private, residential or industrial buildings.



- **Isocanal ALC:** Polyiso foam panel coated on both sides with 80 µm thick embossed aluminum - Foam density: 45 kg/m³. Dimensions 1200 x 4000 mm – Thickness: 20.5 mm.

Declared thermal conductivity 0.022 W/mK

Rigidity class: 300,000 (R5)

Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa

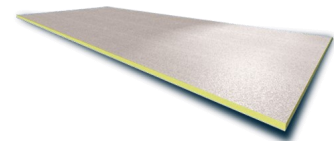
Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B

Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s2, d0

- **Isocanale Ai6:** Polyiso foam panel coated on both sides with 60 µm thick embossed aluminum - Foam density: 35 kg/m³. Dimensions 1200 x 4000 mm – Thickness: 20.5 – 30.5 mm.
Declared thermal conductivity 0.022 W/mK
Rigidity class: 160,000 (R3)
Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s1, d0
- **Isocanale Ai8:** Polyiso foam panel coated on both sides with 80 µm thick embossed aluminum - Foam density: 35 kg/m³. Dimensions 1200 x 4000 mm – Thickness: 20.5 – 30.5 mm.
Declared thermal conductivity 0.022 W/mK
Rigidity class: 200,000 (R4)
Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s1, d0

Applications outside civil, commercial, and industrial buildings

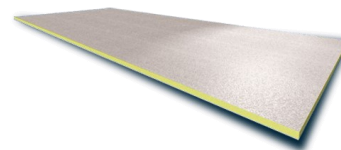
To create air ducts that are particularly resistant to harsh weather conditions, outside public or private buildings, residential or industrial.



- **Isocanal ALE:** Polyiso foam panel coated on the outside with 200 µm thick embossed aluminum and on the inside with 80 µm thick embossed aluminum - Foam density: 45 kg/m³. Dimensions 1200 x 4000 mm – Thickness: 20.5 - 30.5 mm.
Declared thermal conductivity 0.022 W/mK
Rigidity class: 300,000 (R5)
Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s2, d0
- **Isocanal AEB:** Polyiso foam panel coated on the outside with 200 µm thick embossed aluminum and on the inside with 80 µm thick embossed aluminum, covered with an antibacterial lacquer - Foam density: 45 kg/m³. Dimensions 1200 x 4000 mm.
Thickness: 20.5 - 30.5 mm.
Declared thermal conductivity 0.022 W/mK
Rigidity class: 300,000 (R5)
Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s2, d0

Applications in environments with high hygiene requirements

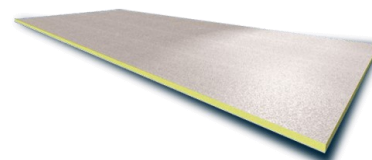
For creating air ducts in hospital environments, for the pharmaceutical or food industry, where air quality and people's safety are the main objectives.



- Isocanale AAL:** Polyiso foam panel coated on the outside with 80 µm thick embossed aluminum and on the inside with 80 µm thick smooth aluminum, covered with an antibacterial lacquer - Foam density: 35 kg/m³.
 Dimensions 1200 x 4000 mm - Thickness: 20.5 mm.
 Declared thermal conductivity 0.022 W/mK
 Rigidity class: 200,000 (R4)
 Microbial activity: >99% (according to ISO 22196)
 Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
 Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
 Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s1, d0
- Isocanale AAB:** Polyiso foam panel coated on the outside with 80 µm thick embossed aluminum and on the inside with 80 µm thick smooth aluminum, covered with an antibacterial lacquer - Foam density: 45 kg/m³.
 Dimensions 1200 x 4000 mm – Thickness: 20.5 mm.
 Declared thermal conductivity 0.022 W/mK
 Rigidity class: 300,000 (R3)
 Microbial activity: >99% (according to ISO 22196)
 Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
 Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
 Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s2, d0

Applications in aggressive environments

To create air ducts in highly aggressive or polluted environments, both for the industrial sector, such as farms or tanneries, and in sports facilities, such as swimming pools.



- Isocanale LB3:** Polyiso foam panel coated on both sides with 80 µm thick embossed aluminum with corrosion-resistant white coloring - Foam density: 35 kg/m³. Dimensions 1200 x 4000 mm – Thickness: 20.5 mm.
 Declared thermal conductivity 0.022 W/mK
 Rigidity class: 200,000 (R4)
 Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
 Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
 Fire reaction of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s1, d0
- Isocanale LB4:** Polyiso foam panel coated on both sides with 80 µm thick embossed aluminum with corrosion-resistant white coloring - Foam density: 45 kg/m³. Dimensions 1200 x 4000 mm – Thickness: 20.5 mm.
 Declared thermal conductivity 0.022 W/mK
 Rigidity class: 300,000 (R5)
 Pressure resistance of pre-insulated duct with bayonet profiles and invisible flange: 3750 Pa
 Air tightness class of pre-insulated duct with bayonet profiles and invisible flange: B
 Reaction to fire of pre-insulated duct with bayonet profiles and invisible flange: Euroclass B – s2, d0

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