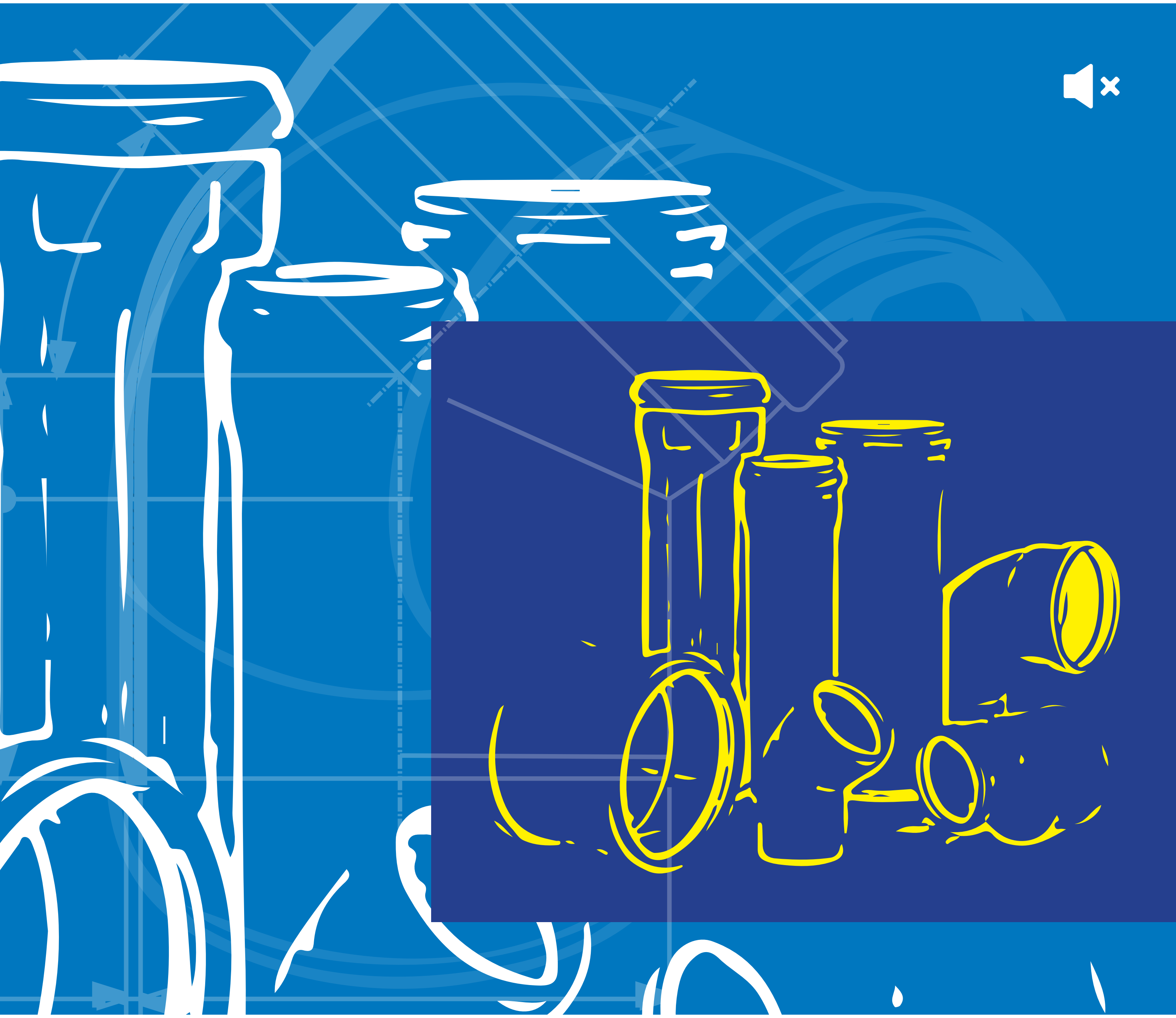
Silent Flow

UPVC PIPES
Sound attenuated systems



THE PIPELINE SPECIALIST

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SILENT FLOW

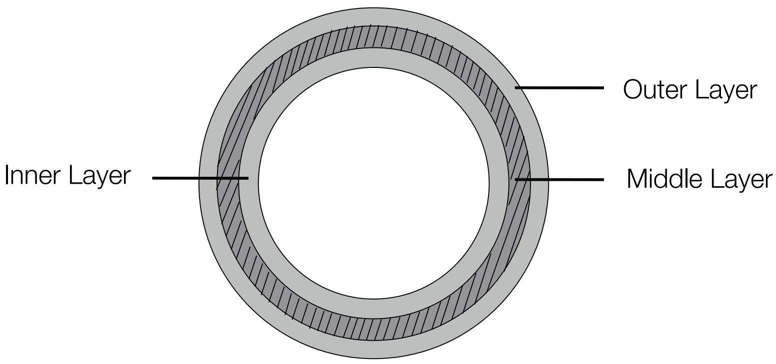
What is Silent Flow ?

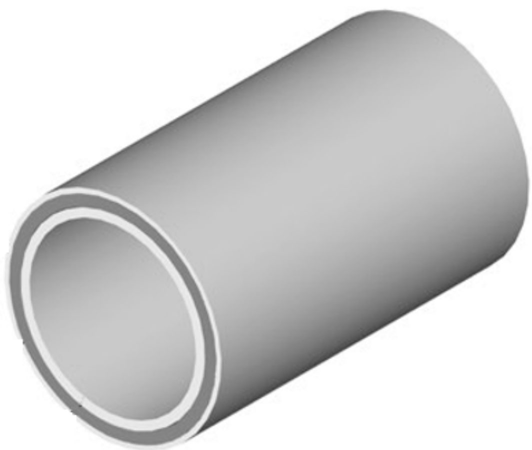
STR silent flow is a combination of PVC pipes, fittings and brackets specially designed to reduce noise emanation during flow of water and waste in the piping system. As such it offers an innovative solution for sound insulation for domestic waste disposal. The function of the system is to lower and/or eliminate the sound discharged from the waste disposal system inside the building.

STR Silent Flow pipes are manufactured from an innovative multilayer structure, recognised as one of the finest technological innovation in the industry. The triple layer technology: (size DN > 110mm)

Silent Flow, Low Noise system is a premium product especially designed for hotels, hospitals, hi-rise buildings, IRS Villas, smart cities and premium projects where regular PVC pipes do not suffice the application requirement. Such projects require a system which is strong enough to meet specific requirements. It has been designed to meet such demands. This thick walled, Silent Flow system is specifically featured with low noise aspects. This makes it suitable for the projects where sound beyond certain decibel level is not desirable. Thus a combination of strength and Low noise aspects has made this product a much better solution for building drainage. This all together new system will set a new trend for that new market segment where expectations are high.

The inner, outer and middle layers are made up of mineralized material which has better sound absorbing characteristics. Thus, the reinforced mineral material will mitigate impacts and vibrations so as to minimize noise pollution and sound waves.





DESIGN SOIL AND WASTE SYSTEMS

The design of Waste Water System is regulated by EN 12056-2.
This European standard applies to waste water drainage systems, which operate under gravity. It is applicable for drainage systems inside dwellings, commercial, institutional and industrial buildings. This guideline provides for main indications and definitions of all elements necessary to a particular project. Definitions are those indicated in the standard EN12056-2. The standard defines systems according to the number of discharge units and branch filling percentage. The first part of the guideline concentrates on definitions and the second part on dimension of the various parts of the system. The third part describes the dimensions calculations and necessary data for a particular design.

Systems configurations

The choice of the type of installation, as provided by law, should be made in accordance with municipal regulations or of the managing companies of the water and sewage system, with the distance of installations from the vertical columns, of the 90° curves required to reach the aforementioned columns and with the maximum difference in height between installations.

According to UNI EN 12056-2 systems are classified as follows.

SYSTEM I
Single discharge stack system with partly filled branch discharge pipes.
Sanitary appliances are connected to partly filled branch discharge pipes. The partly filled branch discharge are designed with a filling degree of 0.5 (50%) and are connected to a single discharge stack.

SYSTEM II
Single discharge stack system with small bore discharge branch pipes
Sanitary appliances are connected to small bore branch discharge pipes. The small bore branch discharge pipes are designed with a filling degree of 0.7 (70%) and are connected to a single discharge stack.

SYSTEM III
Single discharge stack system with full bore branch discharge pipes
Sanitary appliances are connected to full bore branch discharge pipes. The full bore branch discharge pipes are designed with a filling degree of 1.0 (100%) and each branch discharge pipe is separately connected to a single discharge stack.

SYSTEM IV
Separate discharge stack system
Drainage system type I, II and III may also be divided into black water stack serving WC's and urinals and grey water stack serving all other appliances. In most European countries, Italy included, the main adopted system is SYSTEM I. Each of the aforementioned systems can be realised in different configurations, with primary and secondary ventilation, in order to control the pipes pressure and, therefore, odour emissions in the building. It is recommended to place the columns as near as possible to the discharge systems, specifically, to the WC.

Components and sizes

In the following part, components are described and dimensioning process is listed: Design process must respect the following steps:

1. Positioning of vertical stacks and appliances on layouts. It is necessary to put appliances on layout to calculate distances between appliances and vertical stacks (pipes, fittings...) and to verify the minimum width of the screed according to the minimum slope and the maximum number of bends to be applied in case the pipe is within the wall or floor. It is recommended to pay attention to the overall dimensions, not only to the pipe size. Normally, the pipe is equipped with uncoupled fittings, insulations, the fixing brackets and other accessories that increase the actual overall dimension of the pipe.

2. Choose the correct discharge system.
   (After the check indicated in point 2, a system among those the norm indicates must be chosen. In Italy system I is the most used, but all the others can be adopted. If distances cannot be achieved in an unventilated system, a system with no limits in distances and bends is recommended. It is advisable to study national and/or local regulations, as the European norm defines general rules only.)

3. The value of the flowrate must respect the type of appliances, branch and use (hospital, domestic...), it is necessary to determine the correct diameter of the pipe.

4. Flow rate calculation.It is the flow rate value required by the project, and measured according both to the devices connected to a specific branch and their usage (domestic, hospital, etc.)The exact diameter of the pipe will have to be determined basing on this value.

5. Discharge branches dimensioning (diameter, gradiant, etc..) minimum diameter, minimum slope, maximum number of bends and maximum difference in height respect to the vertical stack have to defined, considering the results of point 4, tables 4,5 and 6 (for unventilated systems) and tables 7,8 and 9 (for ventilated systems). Materials will be choosen due to technical and economic exigencies.

6. Ensure external diameters of branch components fit within walls and screeds. This check is necessary to verify all sanitary system components are in compliance with building dimensions, as per previous point calculation).

7. Branch materials (the appropriate materials are to be choosen according to laying method, and waste water quality, other factors also need to be considered described in the specific chapter.)
   It is recommended to pay attention to the overall dimensions, not only to the pipe size. Normally, the pipe is equipped with uncoupled fittings, insulations, the fixing brackets and other accessories that increase the actual overall dimension of the pipe.

8. Calculate flowrate for every vertical stack after calculation at point 5 , it is necessary to calculate the total flowrate of the vertical stack.

9. Vertical stack dimensioning. According to calculation at point 8 and tables 11 and 12, diameters are choosen, considering flowrate and related branch type.

10. Materials for the vertical stack. The appropriate materials are chosen according to laying method, waste water quality and some other factors described in the specific chapter.

11. Discharge drains dimensioning. The dimensions of drains and discharge stacks have to be defined, considering the results at point 5 and 8.

12. Bill of quantities and materials. It is necessary to define quantities and components to realise the system.

FLOWCHART: THE STAGES OF DESIGN

NUMBER AND TYPE OF APPLIANCE

ARCHITECTURAL CONSTRAINTS

Place the vertical stacks and appliances on layouts.

Following chart 5, UNI 12056-2
- Check the distance between appliances and vertical stacks
- Check the maximum number of 90° bends
- Check the maximum height diffrence between appliances

Is it possible to use one of the systems presented in chart 5 without secondary ventilation of the YES branches?

YES

Flowrate calculation for every discharge stack following par.6.3 of the UNI 12056-2 norm

Discharge branches dimensioning (for **non-ventilated** systems), considering the results of tables 4,5 and 6 of the UNI 12056-2 norm

Check of external diameters, branch components depending on thickness of walls and screeds

NO

Flowrate calculation for every discharge stack

Discharge branches dimensioning (for **ventilated** systems), considering the results of tables 7,8 and 9 of the UNI 12056-2 norm

Check of external diameters, branch components depending on thickness of walls and screeds

Choose the **appropriate branch materials**

Vertical stack dimensioning according to calculation in tables 11 and 12 and related to the branch type

Discharge drains dimensioning accordingly to appendix B of the UNI 12056-2 norm

FLOWRATE CALCULATIONS

The flowrate of waste water in the drainage system is given by the sum of sanitary appliances flowrates (Q_{ww}), plus continuous owrate appliances (Q_c) and the pumped water flowrate (Q_p).

The formula for the total flowrate is: $Q_{tot} = Q_{ww} + Q_c + Q_p$
The Q_{ww} is calculated by:

$$Q_{ww} = k \cdot \sqrt{\sum DU}$$

Where K is the frequency factor defined in table 3 page 11 and ∑DU is the sum of discharge units. Discharge Unit (DU) for systems, compliant with UNI EN 12056-2.

SANITARY EQUIPMENT	SYSTEM I	SYSTEM II	SYSTEM III	SYSTEM IV
	DU l/s	DU l/s	DU l/s	DU l/s
LAVATORY, BIDET	0,5	0,3	0,3	0,3
SHOWER WITHOUT COVER	0,6	0,4	0,4	0,4
SHOWER WITH COVER	0,8	0,5	1,3	0,5
URINAL WITH FLUSHING SYSTEM	0,8	0,5	0,4	0,5
URINAL WITH EJECTION VALVE	0,5	0,3	-	0,3
WALL URINAL	0,2*	0,2*	0,2*	0,2*
BATHTUB	0,8	0,6	1,3	0,5
KITCHEN SINK	0,8	0,6	1,3	0,5
DOMESTIC DISHWASHER	0,8	0,6	0,2	0,5
WASHING MASHINE (LOADING MAX 6 KG)	0,8	0,6	0,6	0,5
WASHING MASHINE (LOADING MAX 12 KG)	1,5	1,2	1,2	1,0
WC, CISTERN CAPACITY 4,01	**	1,8	**	**
WC, CISTERN CAPACITY 6,01	2,0	1,8	DA 1,2 A 1,7***	2,0
WC, CISTERN CAPACITY 7,51	2,0	1,8	DA 1,4 A 1,8***	2,0
WC, CISTERN CAPACITY 9,01	2,5	2,0	DA 1,6 A 2,0***	2,5
FLOOR GULLEY DN 50	0,8	0,9	-	0,6
FLOOR GULLEY DN 70	1,5	0,9	-	1,0
FLOOR GULLEY DN 100	2,0	1,2	-	1,3

ABOUT NOISE

About noise

A beautiful flat will lose its pleasantness of comfort when the noise from a neighbour's toilet flush is realised. It will keep you Company everytime. This is the same as a relaxing stay in a luxury hotel when the toilet in a nearby room is too noisy.

Such problems are often caused by a nonconforming design, due to old habits and competence.

Waste water systems have a great impact in noise propagation inside buildings: just think about flushing system, depression into pipes or horizontal branches.

The water movement inside the pipe transmits pressure from water to the air, propagates vibrations to structures and causes noise audible to humans in adjacent areas. [Figure 1]

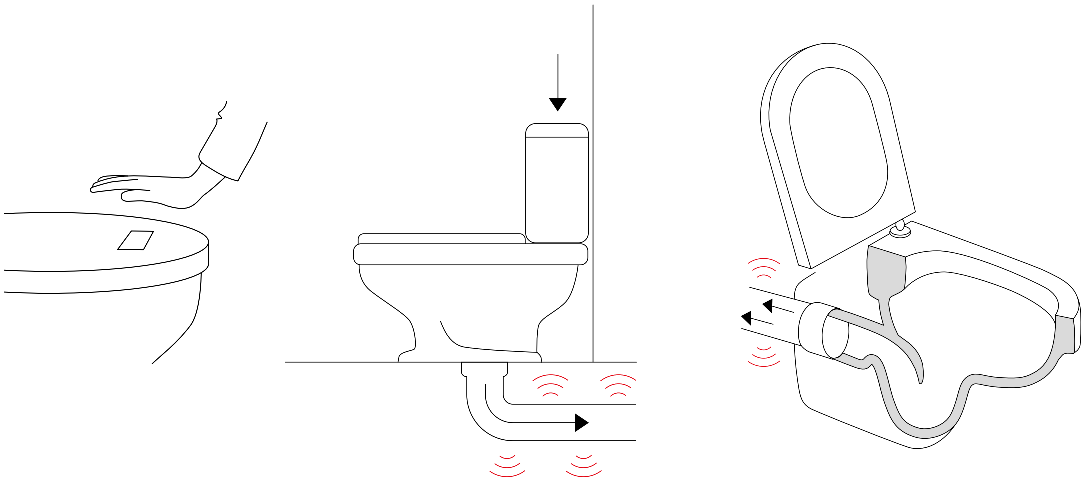


Fig. 1

The sound wave is generated by a variance in air pressure and it is made of several components acting in different ways.

Each component is a wave and has its own frequency of oscillation f.

Structure-borne noise is created by mechanical contact passing on vibration to a structure via an acoustic bridge, while airborne noise comes from a source that causes air to vibrate. Therefore, even if sound is invisible, it is made of real physical components, and it is measurable. 2. The human ear is most sensitive to variation in sound pressure p between $2 \cdot 10^{-5}$ Pascal (audible threshold) and 100 Pascal (pain threshold). Pascal is the measurement unit of pressure.

Experienced noise and caused noise are not directly connected, the human ear filters produced noise and alterates its final perception. A logarithmic scale can explain the mathematic relation: the sound pressure p is converted into level of sound pressure Lp , called deciBel (dB):

$$L_p = 10 \cdot \log\left(\frac{p}{p_0}\right) \longrightarrow deciBel(dB)$$

About noise (Continue)

Where p0 is the known pressure. The deciBel is a number and NOT a measurement unit as it is calculated by a logarithm of two omogenous units.

On a logarithmic scale calculations are different from those on a linear scale. For example, a decibel quantity X, if doubled is not 2X but X+3 (rule of 3 dB). [Figure 2]

This means that in case of two independent discharge pipes 1 and 2 into the same wall partition, having a noise level L1=30dB and L2=33dB in case of simultaneous use the total sound level perception LT will be the sum of L1 and L2:

$$L_T = L_1 + L_2 = 10\log(10^{30/10} + 10^{30/10}) = 10\log(2 \cdot 10^{30/10}) =$$
$$= 10\log(2) + 10\log(10^{30/10}) = 3 + 30 = 33dB$$

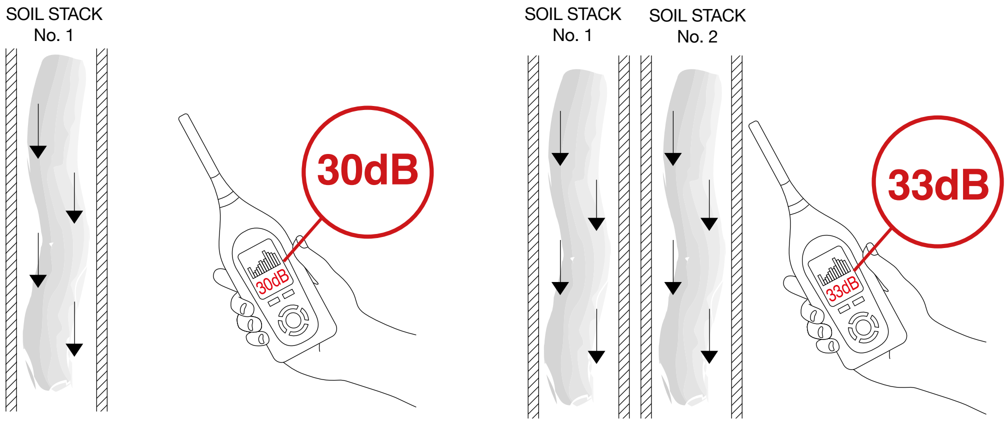


Fig. 2

Therefore in a logarithmic scale, 3 more dB doubles the base quantity, while 3 less dB halves it. The noise of a discharge pipe is estimated by a sound pressure level measurement during a fixed timing during use. The total noise level will result from all frequency components. Every component (flushing, piping, anchorage) produces vibrations and air-borne noise.

ABOUT NOISE

STRUCTURE - BORNE NOISE REDUCTION & INSTALLATION RULES

Structure-borne noise reduction

Mechanical contacts create vibrations in structures. This energy converts into air noise and is audible by human ear. For example, when flushing water passes through soil stacks, it transmits the energy to the vertical duct and makes it move.

Therefore it is necessary to avoid the contact between pipes and near structures to reduce vibration transmission by using resilient materials. The characteristic of a resilient material is to be like a spring dispersing vibrations it receives. Resilience is the ability to cope with stress without changing mechanical characteristics (i.e. an elastic feature). Therefore the resilient material will reduce and then recover its shape (like a spring). This way, it will disperse vibrations it withstands, like the damping of a car on a rugged road.

The parameter to define this property is called dynamic stiffness [MN/m3]. It allows to calculate how resilient a material is when vibrations come from a discharge system.

The lower the dynamic stiffness the better the impact sound insulation of a material. Resilient materials may be plastic or natural fibres, mineral fibres or rubber.

Resilient material act as a spring, while rigid or massive materials are not able to limit the propagation of vibrations.

Installation rules

In order to reduce the propagation of the vibrations due to the discharge systems, decoupling clamps (of resilient material along the tube-collar contact) or damping coating (PE or PP foam) are used; if properly positioned, these can greatly reduce the part of the sound energy that is transmitted from the pipe to the external environment through building partitions, as they uncouple mechanical contact.

Discharge pipes cannot be connected to the down pipe or to the drains in the over or under pressure areas, as water shocks and sound waves are higher there. In a 90° bend, pressure and noise are at the highest because of the rapid change of the flow direction. We can reduce pressure and noise phenomenon by 35% using two bends 45° and a pipe between them (the pipe must be long more than twice the diameter of the bend. The water flow slows down after the impact. [Figure 3]

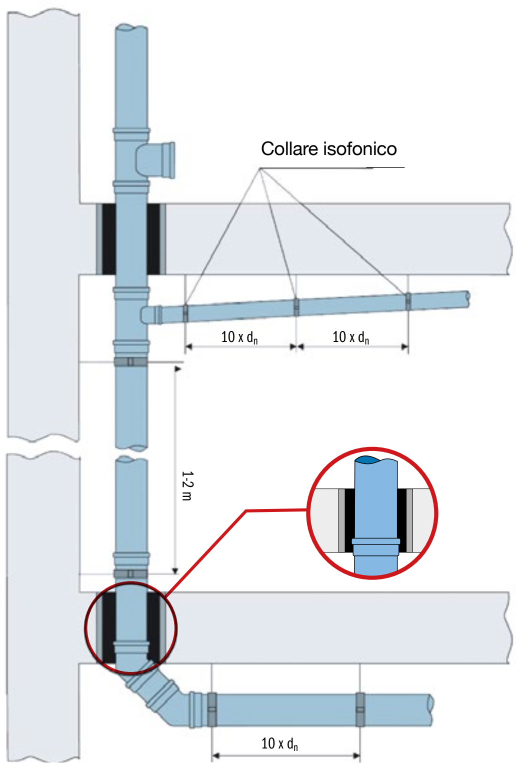


Fig. 3: Pipe section with clamps, coating and bends.

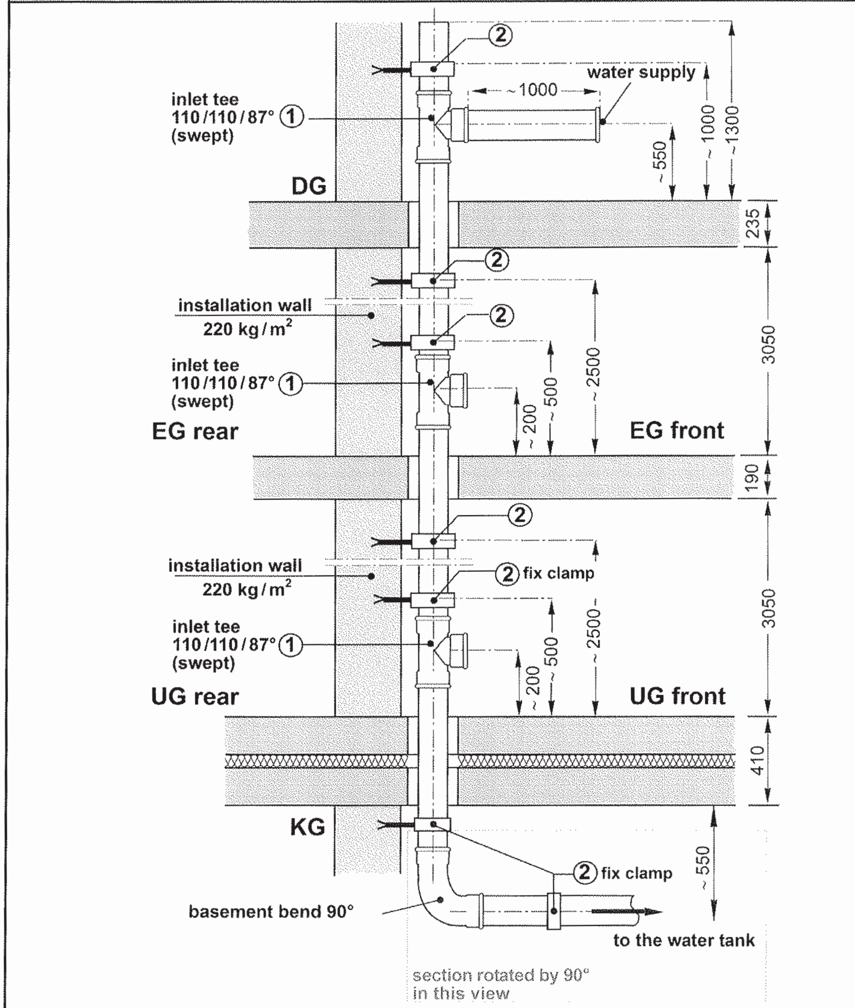
ABOUT NOISE

LABORATORY CERTIFICATIONS

Laboratory certifications

In aim to certificate the noise level of the drainage systems (piping, junction systems, bends, noise-insulating collars), laboratory tests are carried out, in conformity to the UNI EN 14366 norm: "Laboratory measurement of noise from waste water installations". The norm specifies methods of laboratory measurement of the airborne and structure-borne noise induced form piping systems and relevant accessories for wastewater and rainwater (therefore, it does not refer to the actual source of wastewater: toilets, bathrooms, showers).

Detailed results Client: SOCIETE DES TUBES ET RACCORDS MARKETING LTEE, Old Moka Road. Bell Village. P.O. Box 98, Port-Louis, MAURITIUS	P-BA 104/2015e figure 4



Installation plan of the test set-up in the test facility.

Test specimen: Wastewater installation system consisting of plastic pipes and fittings "PPP/PSL "LOW-NOISE" uPVC EN 1329-1, 110X5.0 "B" (manufacturer: PPP piping systems ltd) with standard steel pipe clamps with rubber inlay "108-114" (made by COFIX).

Fraunhofer IBP	The test was carried out in a laboratory, accredited according to DIN EN ISO/IEC 17025:2005 by DAkkS. The accreditation certificate is D-PL-11140-11-01.

Above is an extract of test report for STR "SILENT FLOW" from Fraunhofer Germany

LABORATORY CERTIFICATIONS

Result:

"PPP/PSL "LOW-NOISE" uPVC EN 1329-1, 110X5.0 "B" (manufacturer: PPP piping systems ltd) with standard steel pipe clamps with rubber inlay "108-114" (made by COFIX).				
Flow rate [l/s]	0.5	1.0	2.0	4.0
Installation sound level $L_{AFeq,n}$ (L_{In}) [dB(A)] **according to DIN 4109** measured in the basement test-room UG front	44	48	51	55
Installation sound level $L_{AFeq,n}$ (L_{In}) [dB(A)] **according to DIN 4109** measured in the basement test-room UG rear	17	23	27	33
Installation sound level $\overline{L_{AFeq,nT}}$ (L_{In}) [dB(A)] **according to VDI 4100** measured in the basement test-room UG front	42	46	49	53
Installation sound level $\overline{L_{AFeq,nT}}$ (L_{In}) [dB(A)] **according to VDI 4100** measured in the basement test-room UG rear	15	19	24	30
Airborne sound pressure level $L_{a,A}$ [dB(A)] **according to EN 14366** in the basement test-room UG front	44	48	51	55
Structure-borne sound characteristic level $L_{sc,A}$ [dB(A)] **according to EN 14366** in the basement test-room UG rear	14	20	25	30

FÖRDERUNG DER ANGEW... Fraunhofer IBP ...CHUNG E.V.

Test date: May 12, 2015

The same document specifies that the data provided through laboratory tests are used to confront different types of drainage systems but the results are not applicable for a direct calculation of the internal noise inside the building. This part is determined by UNI EN ISO 12354-5 norm. The UNI EN 14366 norm test is applicable for pipes of any material, with natural ventilation and commonly used diameter (up to 150 mm).

The test chamber's volume has to be at least 50 mm3 and the drop height range between 5,8 and 7,5 m; the standard test wall is defined as a single wall of bricks, filled blocks or concrete, with the surface volume of 200 ±50 kg/m2 (included plaster on both sides). The tested piping system is first installed under particular conditions and placed on the attachment points indicated by the constructor.

Then, various water fluxes (respectively 0,5, 1, 2 and 4 l/s) are applied and maintained inside the system until the end of the test. Thus both, the airborne noise level irradiated directly from the sample and the vibration or structure borne noise level is tested. For this reason, numerous parameters come attached to the certifications, such as:

- sound pressure level measured frontally in the receiving room
- sound pressure level measured in the adjacent room
- sound pressure level of the airborne noise
- sound pressure level characteristic for vibrations
- structural sensibility level of the sample wall

The first two are measures of the laboratory noise that can give an idea of the behaviour of the piping system itself, but do not deliver full data, neither to allow a comparison of the various products, nor to foresee the behavior of the system after installation.

The last three levels contribute to final parameters form: La,A (normalised sound pressure level of the vibrational noise weighted A). The last two parameters are going to be used in the calculation, according to method included in UNIEN ISO 12354-5:2009 norm.

ACOUSTIC DESIGN OF DISCHARGE SYSTEM

The acoustic properties of discharge systems can be calculated using the method indicated in the standard UNI EN 12354-5:2009. It is fundamental to know all factors that can generate and propagate noise inside discharge systems. Perceived noise in the environment is originatedd by two sources:
1. airborne noise
2. vibrations

Both kinds of "structural noise" originate inside the pipes, but for convenience they are studied separately as they propagate in different ways. As for airborne noise inside the pipe, a part of it remains inside and falls down with fluids, another part propagates outside in the air through near structures to reach the receiver. As shown in Figure 4.

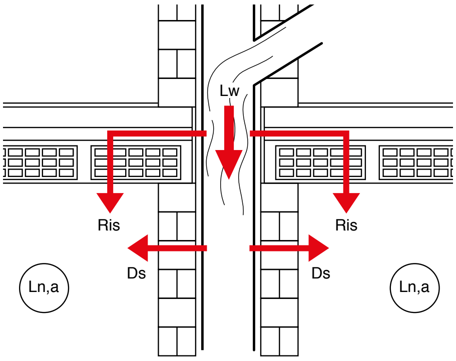


Fig. 4: Airborne noise functioning inside discharge pipes

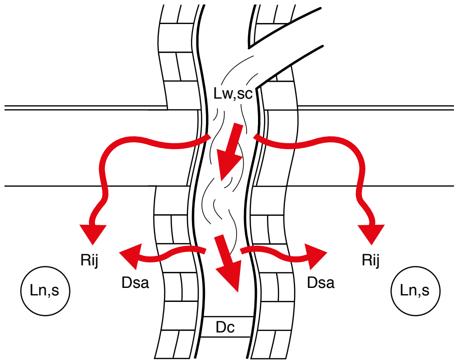


Fig. 5: Vibration noise inside discharge pipes

discharge pipe is caused by the impacts of fluids falling down that move the pipe itself. This vibration propagates through solids inside structures near the pipe to reach the receiver by air. As shown in Figure 5.
The estimate of perceived sound level in a disturbed environment is calculated by this formula:

$$L_n = 10 \cdot \log\left(\sum 10^{\frac{L_{n,d}}{10}} + \sum 10^{\frac{L_{n,a}}{10}} + \sum 10^{\frac{L_{n,s}}{10}}\right) \quad dB$$

where:
L_n is the sound pressure level in the disturbed environment
$L_{n,d}$ is the airborne sound pressure level connected to the free fall of the fluid into the pipe

$L_{n,a}$ is the sound pressure level propagating out of the pipe into the environment
$L_{n,s}$ is the sound pressure level caused by vibrations

Obviously, when many pipes are present and concurrently operating in the structure, the final result will be the sum of many contributions. It should be pointed out that this formula is valid both for the discharge stacks and for the air ducts. The formula provides for three different types of contributions, which in turn are caused by many variables.

Airborne sound pressure level connected to the free fall of the fluid inside the pipe
This relation is connected to the noise that flows through the pipe and exits directly in the measured environment. However, as no discharge pipes are installed into living spaces, this component of airborne noise is not considered.

Sound pressure level coming out from the pipe and propagating into the environment
This relation is connected to the portion of noise that manages to escape from the pipe, to propagate through the wall partitions and to spread in the measured environment; therefore it is connected to the sound insulation characteristics of the crossed partitions and to the shape and sound-absorbing characteristics of the environment that contributes to the airborne noise propagation. The mathematical formula can be as follows:

$$L_{na} = L_w + D_s - R_{ij,ref} - 10 \cdot \log \frac{S}{S_{ref}} - 10 \cdot \log \frac{A_{ref}}{4} \quad dB$$

where:
$L_{n,a}$ is the level of sound pressure escaping from the soil stack and propagating in the environment.
L_w is the sound power level of the source (discharge stack pipe) (dB)
Dsis the transmission of the sound from the source to the wall partition (dB)
R_{ij},ref is the contribution of lateral transmission (dB)
S is the surface of the wall partition [m^2]
S_{ref} is the reference surface equal 10 m^2
A_{ref} is the sound-absorbing reference surface equal 10 m^2

Obviously, if sources are more than one, results will be added together.
As for the L_w, this data is certified by the manufacturer's laboratory (for pipes, discharge stacks, etc ...) according to the above-described UNI EN 14366.
It is necessary to find the date in the certificate. This is a sound pressure level that has to be converted into sound power level L_w using the following formula::

ntal branches.
ɜr movement inside the pipe transmits
ɜ from water to the air, propagates

The D_s contribution is related to the semi reverberant field inside the environment that contributes to the airborne noise propagation; it takes into account the present sound absorption and the directivity of the source. It is obtained by the following formula::

$$D_s = 10 \log \left(\frac{Q'}{4\pi r^2} + \frac{e^{-\frac{A_s}{S_t}}}{A_s} \right) \cdot S_i \qquad dB$$

where:
Q' corresponds to the directivity of the source
(Q=1 near sound source, Q' = 2 source close to a flat surface, Q' = 8 source at a corner)
r is the average distance between the source and the wall element [m]
S_t is the total area of the surfaces of the source room [m2]
A_s is the equivalent sound absorption area of the source room [m2] that is obtained by the following equation:

$$A_s = \alpha_i \cdot S_i$$

Where:
α_i is the apparent sound absorption coefficient of the S_i surface S_i

the Rij,ref refers to lateral transmissions, i.e. all noise air propagation paths generated by pipes, transmitted to wall partitions they are inserted in and to near partitions. This contribution depends on the sound insulation and the surface mass of such partitions; the UNI EN 12354-1 suggests the following mathematical formulas to quantify each propagation path:

$$R_{Ff,w} = \frac{R_{F,w} + R_{f,w}}{2} + \Delta R_{Ff,w} + K_{Ff} + 10\log\frac{S_s}{l_0 l_f} \quad dB$$

$$R_{Fd,w} = \frac{R_{F,w} + R_{s,w}}{2} + \Delta R_{Fd,w} + K_{Fd} + 10\log\frac{S_s}{l_0 l_f} \quad dB$$

$$R_{Df,w} = \frac{R_{S,w} + R_{f,w}}{2} + \Delta R_{Df,w} + K_{Df} + 10\log\frac{S_s}{l_0 l_f} \quad dB$$

Where:
$R_{F,w}$ is the sound reduction index of the flanking element F in the source room (dB)
$R_{f,w}$ is the sound reduction index of the flanking element f in the source room (dB)
$\Delta R_{Ff,w}$ is the sound reduction index improvement by additional lining on the source side of the flanking element (dB)
$\Delta R_{Fd,w}$ is the sound reduction index improvement by additional lining on the source side of the separating element at the receiving side (dB)
$\Delta R_{Df,w}$ is the sound reduction index improvement by additional lining on the receiving element at the flanking element (dB)
K_{Ff} is the vibration reduction index for transmission path Ff (dB)
K_{Fd} is the vibration reduction index for transmission path Fd (dB)
K_{FDf} is the vibration reduction index for transmission path Df (dB)
S_s is the separating element area [m²]
If S_s the common coupling length of the junction between separating element and the flanking elements F and f [m]
l_0 is the reference coupling length equal to 1 meter
All terms relating to sound insulation are calculated using the same rule. The terms referring to the sound insulation improvements are calculated using the template provided by the UNI / TR 11175, which refers to the resonant frequency of composite elements and can be expressed as:

$$\Delta R_w = 73 - \frac{R_{w,ml}}{2} - 20\log f_0$$

Where:
$R_{w,ml}$ is the sound absorbing power of the wall without additional layers. (dB)
f_0 is the resonance frequency [Hz] calculated as follows::

$$f_0 = 50\sqrt{\frac{1}{d}\left(\frac{1}{m'_1} + \frac{1}{m'_2}\right)}$$

Where:
m'_1 is the surface mass of the wall without additional layers [kg/m²]
m'_2 is the surface mass of the additional layers [kg/m²]
d is the dimension of the interspace between the wall and the additional layer [m]
The reduction of vibrations can be calculated according to the UNI EN 12354-1, Appendix E.
The method defines reductions and the mass relations of the near partitions, as follows:

$$K_{13} = 5{,}7 + 14.1 \cdot M + 5.7 \cdot M^2 \quad dB$$

$$K_{12} = 5{,}7 + 5.7 \cdot M^2 \quad dB$$

ACOUSTIC DESIGN OF DISCHARGE SYSTEM

M meaning mass relation such as: $M = \frac{m'_i\neg}{m'_i}$

Where:
$m'_i\neg$ is the surface mass of the element in the transmission path ij [kg/m^2]
m'_i is the mass of the perpendicular element the joint [kg/m^2].

Sound pressure level caused by vibrations
This definition takes into consideration the effect of the movement and the consequent vibrations caused by the free fall of the discharge fluids on the supporting structures.
It depends from :
- liquids
- fastening
- kind of material
- vibrational sound power
- lateral trasmission

So this result can be reported as follows:

$$L_{n,s} = L_{wsc} - D_c - D_{sa} - R_{ij,ref} - 10\log\frac{S_i}{S_{ref}} - 10\log\frac{A_{ref}}{4} \quad dB$$

Obviously if many existing sources are present, all values can be summed up.
As far as the definition Lwsc is concerned, this is supplied by the producer on the Lab certification in compliance with the standard UNI EN 14366. The rate to use is the one identified in the certification as L_{sc}. It's a sound pressure level which has to be converted into L_{wsc} sound power level by using the following formula:

$$L_{wsc} = L_{sc} + 8 \cdot \log f + 23.5 \qquad dB$$

Where:
f is the center band frequency of the measured octave band [Hz].

The D_c definition refers to the in-built coupling between the source and the structures it is in contact with. This definition includes the resilient and/or muffling effect of all the materials or coatings, which allow the coupling of the source/stack with the structures it is fixed to. As a matter of fact, the less stiff (or less resilient) the contact is, the easier it can dissipate the given vibration- by moving. Therefore the D_c result can be reported as follows:

$$D_c = -10\log\mathrm{Re}\left\{Y_i\right\} - 30 \qquad dB$$

Where Y_i is the system mobility conveyed by a complex number of which just the real part is taken into consideration. Such figure, by definition, must be negative.
However, for the common practical cases, this figure is essentially real and it depends on the element surface mass and on its own bending moment. The above-mentioned equation is as follows:

$$Y_i \approx \frac{f_c}{150000 \cdot t}$$

Where:
f_c is the critical frequency of the system [Hz]
t is the element thickness [m]
As far as calculation of f_c is concerned, the standard UNI EN 12354-1 could be useful, as it supplies the following formula:

$$f_c = \frac{c_0}{1.8 \cdot c_L \cdot t}$$

Where:
c_0 is the airborne sound speed in standard conditions [m/s] and equal to about 340 m/s
c_L is the sound longitudinal speed inside the propagation element [m/s]
t is the element thickness [m]
The c_L longitudinal sound speed -into an elastic means- depends on the correlation between the elastic modulus and the density of the material as for the following formula:

$$c_L = \sqrt{\frac{E}{\rho}} \qquad \left[\frac{m}{s}\right]$$

Where:
E is the elastic modulus of the resilient element [Pa] ρ is the density of the resilient material [kg/m³]
The D_{sa} adjustment factor refers to the conversion of the noise from vibrational to airborne noise, that is from the propagation inside the wall, to the propagation in the air.
If we also use what is proposed by standard UNI EN 12354-1, B appendix, this result could be stated as follows:

$$D_{sa} = 10 \log \frac{400 f_c \sigma}{m' f} \qquad dB$$

Where:
$_{fc}$ is the critical frequency of the system [Hz] σ is the diffusion factor of the sound wave m' is the surface mass of the wall partition [kg/m²]
f is the band center frequency of the measured octave band [Hz]
The σ diffusion factor may be calculated by using standard UNI EN 12354-1 appendix B.
This method is very complicated and requires the knowledge of other data. As a first estimate, to be sure, we can speculate the transmission of the sound wave is complete: in this case the diffusion factor becomes σ = 1.

SILENT FLOW BRACKETS "PHONOKLIP"

Silent Flow brackets "PHONOKLIP"

STR silent flow pipe brackets are of make PHONOKLIP® of world renown brand GIRPI.

More that ever, it has become of utmost importance to fight against noise pollution caused by the evacuation of waste water, storm water etc.

STR the pipeline specialist of piping materials innovates in providing the complete solution for the transport of cold and hot fluids.

Hence, introducing the new acoustic clamp designed to meet the needs of hanging system for the range of acoustic evacuation.

System advantages:

- High quality virgin material.
- UV Stabilised.
- QMS certified systems.
- Multilayer technology.
- Special brackets to reduce vibrations.
- Easy connection both SW & RRJ assembly.
- Pipe range 40 – 160 mm (Locally manufactured)
- Fittings & brackets from REDI & GIRPI.
- System tested by Fraunhofer Germany.

SILENT FLOW:
PIPE RANGE

SILENT FLOW: PIPE RANGE

Pipe standard : EN 1329
Low noise system designed to EN12056:2000
Acoustic performance : EN 14366

PIPE DIAMETER	WALL THICKNESS	SOCKET TYPE	
(mm)	(mm)	SW	RRJ
40	3	√	√
50	3	√	√
75	4	√	√
110	5	√	√
160	5.5	√	√

Note :
For bigger sizes, please contact our Technical department.
It is highly recommended to go in solvent weld joints for all horizontal installations specially false ceilings and flooring.
However, for sizes DN 75-110mm in vertical position, the rubber ring joints shall be the preferred installation type.

SILENT FLOW: FITTINGS RANGE

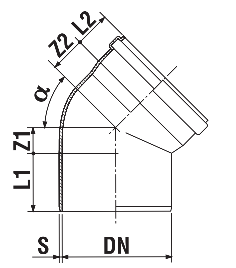
phono))line

High Quality : Make : REDI

Sound performance certified 12 dB at 2/ls flow rate
Fire resistance Class B s2 d0

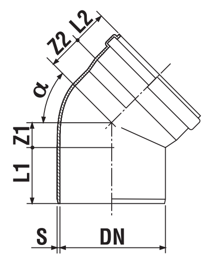
BEND/COUDE 45 DEG

Size (DN) mm	Code
40	REEL4-PH040
50	REEL4-PH050
75	REEL4-PH075
110	REEL4-PH110
160	REEL4-PH160



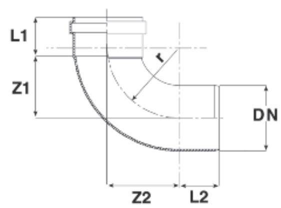
BEND/COUDE 87 DEG

Size (DN) mm	Code
40	REEL9-PH040
50	REEL9-PH050
75	REEL9-PH075
110	REEL9-PH110
160	REEL9-PH160



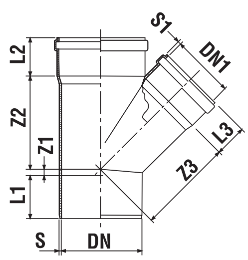
LONG RADIUS BEND 87 DEG

Size (DN) mm	Code
110	REEL9-PH110L



Y BRANCH / CULOTTE 45 DEG

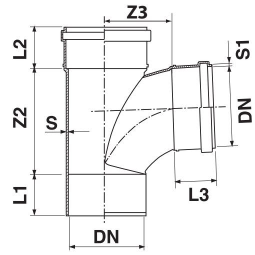
Size (DN) mm	Code
40/40	REET4-PH040
50/50	REET4-PH050
75/75	REET4-PH075
110/110	REET4-PH110
160/160	REET4-PH160DS



SILENT FLOW: FITTINGS RANGE

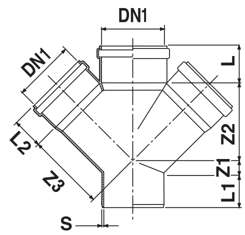
LONG RADIUS BRANCH/T GRANDE RAYON

Size (DN) mm	Code
110	REET4-PH110DS

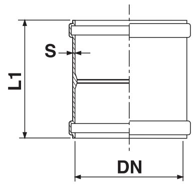
DOUBLE BRANCH 45 DEG/CULOTTE DOUBLE 45 DEG

Size (DN) mm	Code
110/110/110	RE-RV144PH

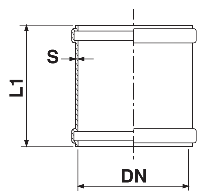
COUPLER WITH CENTRAL STOP/MANCHON AVEC BUTEE

Size (DN) mm	Code
75	REC04 - PH075
110	REC04 - PH110

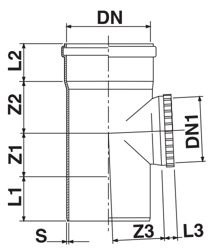
SLIP COUPLER

Size (DN) mm	Code
40	RCOU-PH040S
50	RCOU-PH050S
110	RCOU-PH110S
160	RCOU-PH160S

ACCESS PIPE

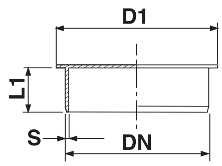
Size (DN) mm	Code
110	REET9 - PH110

SILENT FLOW: FITTINGS RANGE

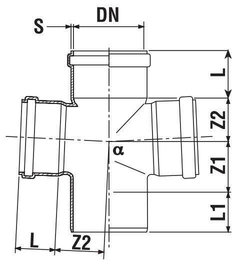
SOCKET PLUG / CAP

Size (DN) mm	Code
40	RECAP-PH040
50	RECAP-PH050
110	RECAP-PH110

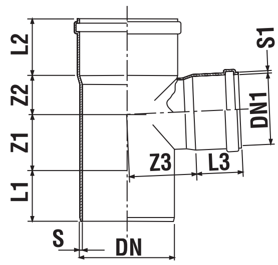
DOUBLE BRANCH 90 DEG

Size (DN) mm	Code
110	RE-RV188PH

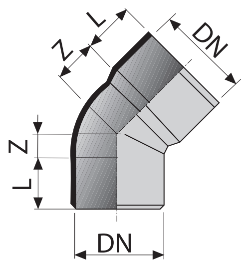
BRANCH/TEE

Size (DN) mm	Code
50X50X90 deg	REET9-PH050DS
110X110x90 deg	REET9-PH110DS
110X50x90 deg	RERT9-PH1105DS
110x40x45 deg	RERT4-PH1104DS
110X50X45 deg	RERT4-PH1105DS
110X75X45 deg	RERT4-PH1107DS
160X110X45 deg	RERT4-PH16011DS

BEND 45°

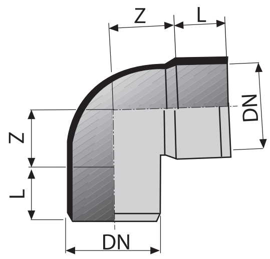
Size (DN) mm	Code
110	REEL4-PH110SW

SILENT FLOW:
FITTINGS RANGE

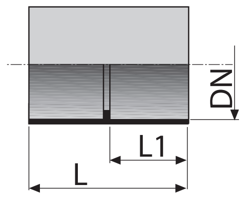
BEND 87°30’

Size (DN) mm	Code
110	REEL9-PH110SW



COUPLER WITH CENTRAL STOP

Size (DN) mm	Code
110	REC04-PH110SW



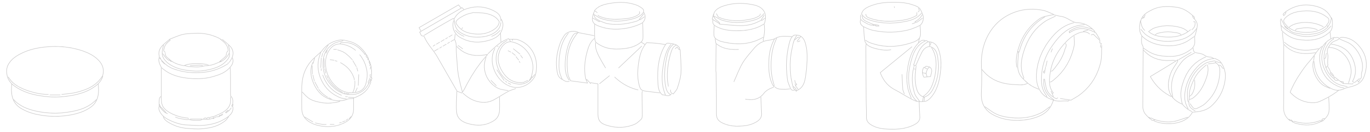
PHONOKLIP BRACKETS

Size (DN) mm	Code
50 M7	FF-PHCLIP507
50 M8	FF-PHCLIP508
75 M7	FF-PHCLIP757
75 M8	FF-PHCLIP758
110 M8	FF-PHCLI110
160 M10	FF-PHCLI160

Reference:
Source of technical information from

REDI

TECHNICAL CATALOGUE
phono))line
Sound attenuated systems



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