5

TECHNICAL MANUAL

WASTE SYSTEMS

Waste systems with ventilation branch fittings

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WASTE SYSTEMS WITH VENTILATION BRANCH FITTINGS

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WASTE SYSTEMS WITH VENTILATION BRANCH FITTINGS

As mentioned in the chapter dedicated to the design, waste systems equipped with ventilation branch fittings do not require the use of parallel or secondary ventilation, thus allowing elevated flows to be discharged in relatively small diameters. These advantages are due to the particular geometrical characteristics of the ventilation fittings, as shown below.

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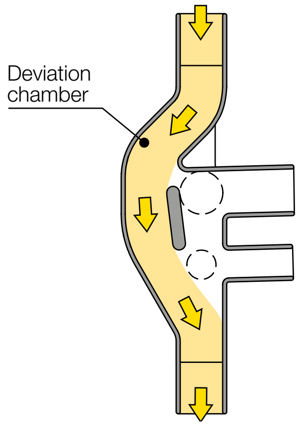
5.1 The operating principle of ventilation branches

The particular internal geometrical configuration of the ventilation branch fitting guarantees the functionality of the entire waste system and ensures an excellent air circulation in the waste stack. The peculiar aspects of this fitting are the following ones:
- It reduces the waste flow speed in the waste stack.
- It ensures an excellent ventilation both of the stack and the horizontal branches thus limiting pressure fluctuations (both positive and negative pressure).
- It avoids the formation of hydraulic plugs keeping a stable and regular flow from the branches to the vertical waste stack.
- It prevents the inlet of foam or the formation of return flows from the stack to the horizontal branches.
- The ventilation fitting must be acoustically insulated if the installation generates noise levels greater than those allowed by the legislations in force.

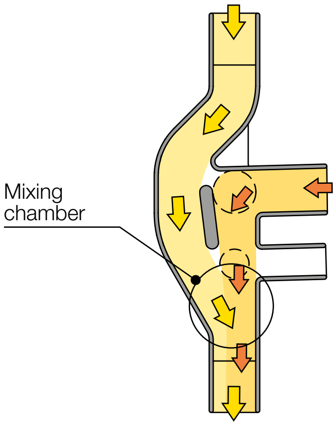
The ventilation branch fitting, also called VBF, is produced in different plastic materials that meet the installation needs, among which acoustic performances, mechanical characteristics and fire-resistant features.

Figure 5.1 Ventilation fittings.

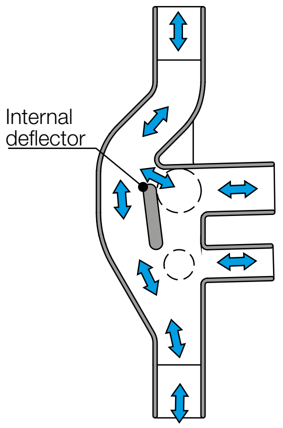
The above-mentioned characteristics are achieved thanks to the particular internal configuration of the ventilation branch fitting that is made up of three main sections: a deviation chamber, a mixing chamber and an internal deflector.



Deviation chamber
The deviation chamber has the purposes of reducing the flow velocity in the waste stack before it could reach the maximum value and balancing pressure variations that cause traps malfunctions. It deviates the descending flow from the top storeys moving it from the horizontal connections at each storey.



Mixing chamber
The mixing chamber has the purpose of allowing the waste water from the horizontal branch connections to enter the ventilation branch without interference from the flow of water from storeys above. The mixing does not take place right after the inlet, but the flow from the storey higher-up is mixed to the one from the horizontal branches when both flows are already inside the pipe and therefore below the connection.



Internal deflector
The internal deflector has the purpose of separating the deviation chamber from the inlet zone of the horizontal branch connections. It is characterised by an opening that guarantees the circulation of air and the adequate ventilation.

The ventilation branch is the result of "merging the conventional vent stack with the waste stack".
This system, in fact, offers numerous advantages as compared with a parallel ventilation system and in particular:

- Waste systems with ventilation branches guarantee lower pressure levels in relation to the flow discharged as compared with a parallel ventilation system.
- Waste systems with ventilation branches guarantee lower pressure levels in relation to the height of the fall of the waste water as compared with a parallel ventilation system.
- Even in the event of an excess discharge in the waste stack, a system with ventilation branches will guarantee excellent functioning of the traps without detrimental reductions of the hydraulic seal.

5.2 Characteristics of ventilation branch fittings

The ventilation branch is produced in two diameters, DN 100 (OD 110 mm) and DN 150 (OD 160 mm), both with the possibility of having up to 6 connections.

- The fitting has 3 DN 100 (OD 110 mm) upper connections for sanitary fixtures such as urinals, WCs, washbasins, bidets, showers, bathtubs, sinks or any other sanitary fixture with a drainage unit DU of 2.5 l/s and 3 DN 70 (OD 75 mm) lower connections for any sanitary fixture with a drainage unit DU of 1.5 l/s (WCs are therefore excluded).
- The maximum capacity of each ventilation branch fitting is $\sum DU \leq 25$ l/s. (See Figure 5.3).
- Connections with horizontal branches that have diameters greater than the diameter of the ventilation branch fitting connections are not allowed.
- Horizontal branches, with lower diameters than the connections ones, can be created using reduction fittings.
- The connections of the ventilation branch fitting can all be used simultaneously.

Figure 5.2 Ventilation fitting connections.

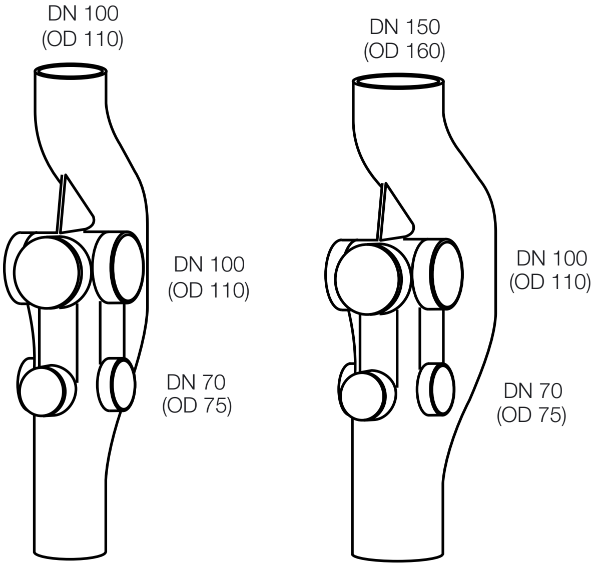
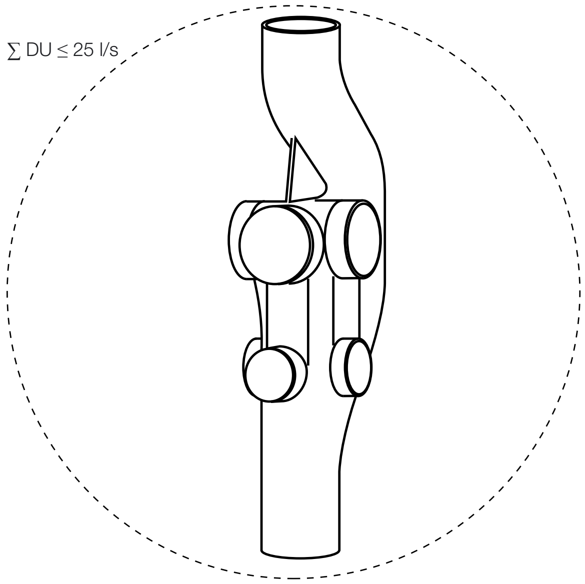


Figure 5.3 Maximum capacity of each ventilation branch fitting.



5.3 Design and sizing of waste systems with ventilation fittings

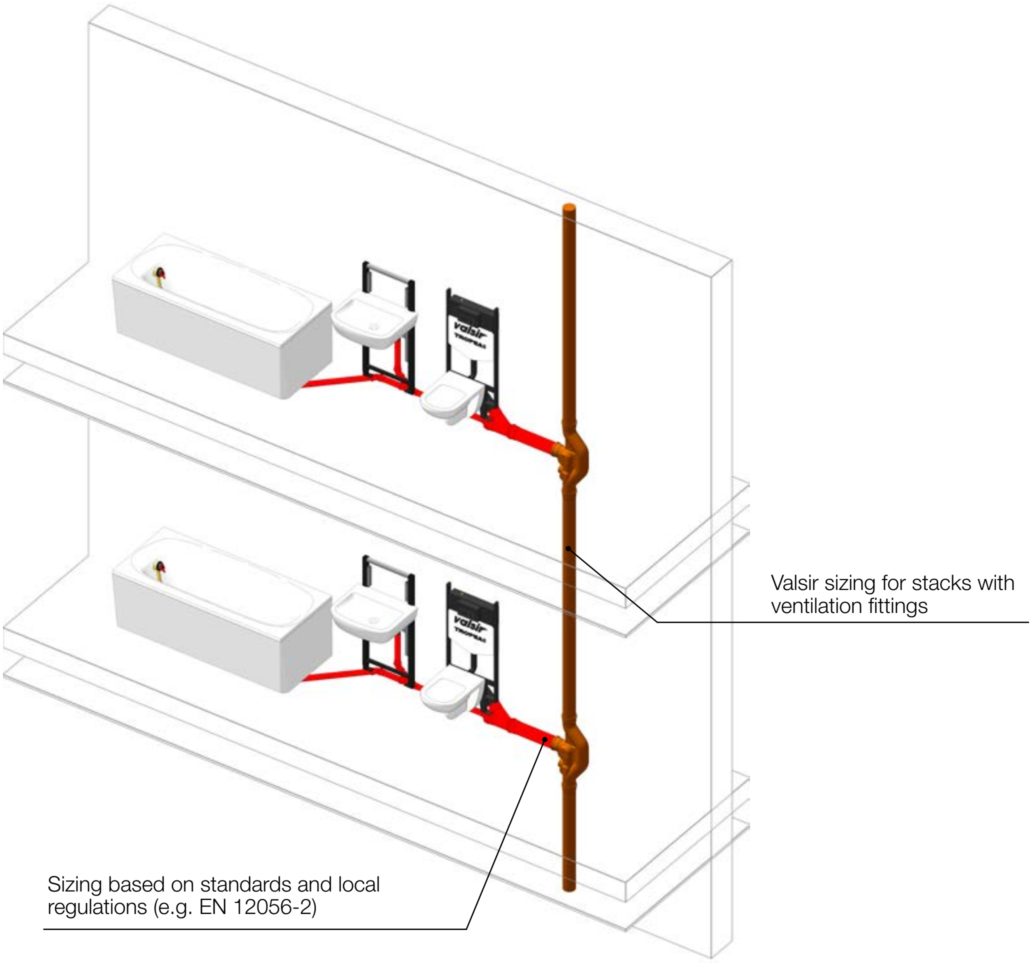
While the sizing of the branches and the collector pipes must be carried out using the calculation methods established by local standards and regulations (e.g. EN 12056-2), the calculation of the waste stack equipped with ventilation branch fittings requires the application of specific rules as follows. In the countries, in which exist local regulations for the sizing of the ventilation branch fittings system, adopt the following ones (see e.g. Australian and New Zealand regulation AS/NZS 3500.2:2018).
The sizing here proposed consists in comparing the project flow of the waste stack with the maximum project flow indicated in the following table.

Table 5.1 Maximum waste flows of the waste stacks with ventilation fittings.

Diameter of the stack		Maximum permissible capacity of the stack K=0.5 ∑DU	Maximum project flow of stack $Q_{ww,max}$	Maximum number of “standard type apartments”* to be connected to the stack
DN	OD			
[mm]	[mm]	[l/s]	[l/s]	
100	110	676	13.0**	100
150	160	3003	27.4***	448

* A “standard type apartment” is composed of a kitchen with sink and dishwasher (max. capacity 6 kg) and a bathroom with basin, bathtub, washing machine, bidet and water closet (with 9 l flush cistern) for a total flow of 6.7 l/s. The calculation takes into account a simultaneity coefficient of K=0.5.
** Values above 10 l/s are allowed, but strictly related to the system configuration and to the design choices that characterize it (direction changes, ventilation branches length, number of sanitary fixtures per floor, common ventilations, etc.). In such cases, it is recommended to involve Valsir technical department.
*** Values above 21.1 l/s are allowed, but strictly related to the system configuration and to the design choices that characterize it (direction changes, ventilation branches length, number of sanitary fixtures per floor, common ventilations, etc.). In such cases, it is recommended to involve Valsir technical department.

Figure 5.4 Sizing rules



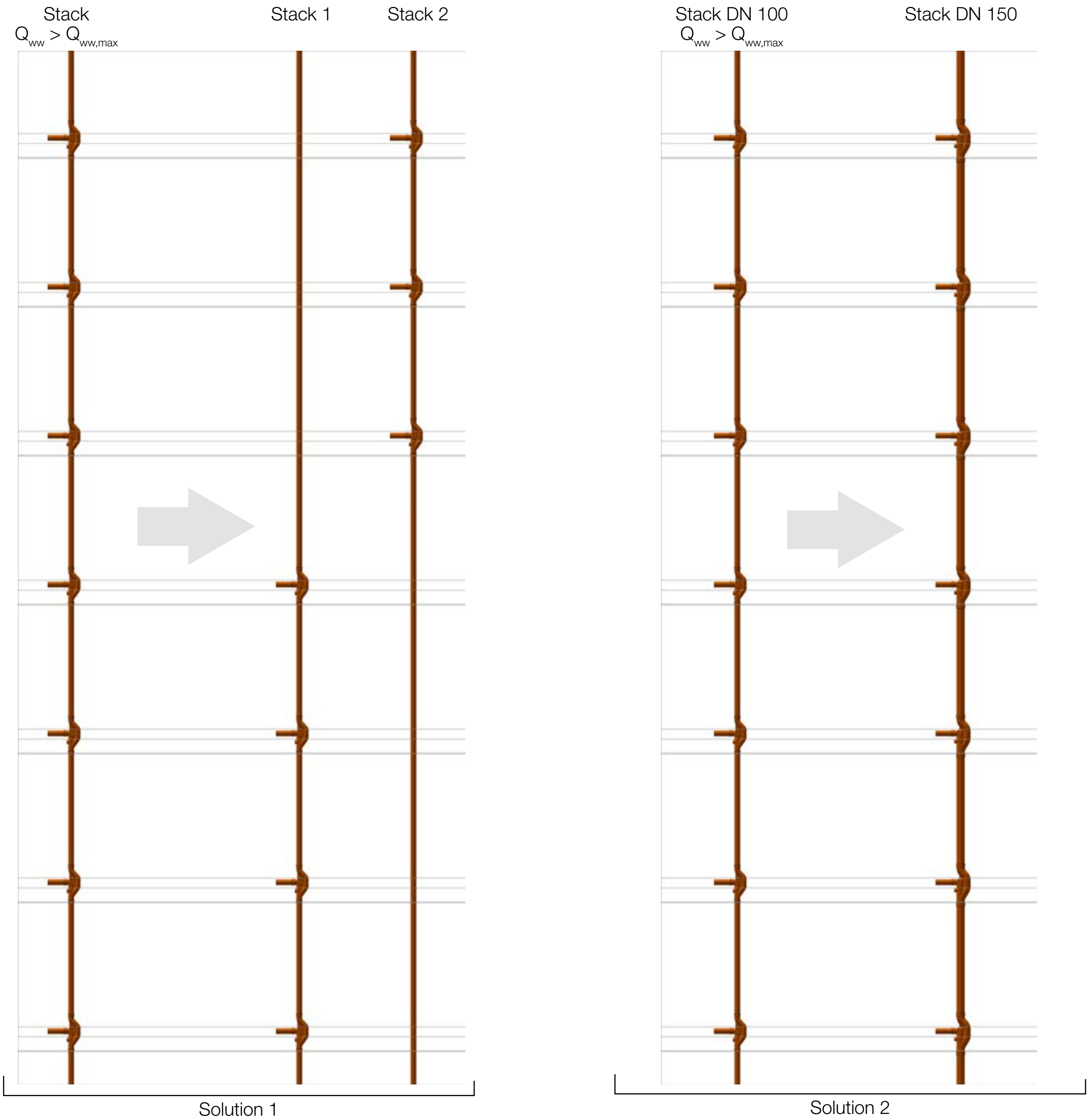
Waste systems with ventilation branch fittings have far greater flow capacities than any other type of waste system described in previous chapters. European Standard EN 12056-2 indicates the maximum flow rate that a waste stack can discharge in relation to the ventilation system adopted; comparisons with systems using ventilation branch fittings are therefore straightforward.

Table 5.2 Comparison between different waste systems, DN 100 (OD 110) waste stack.

Waste system	Max. flow rate $Q_{ww,max}$ [l/s]	
	DN 100 (OD 110)	DN 150 (OD 160)
Primary ventilation with right-angle branch	4.0	9.5
Parallel or secondary ventilation with right-angle branch	5.6	12.4
Ventilation branch fitting	13.0	27.4

If the project flow rate exceeds the limits indicated in the table, segmentation is required and the total load must be distributed to different stacks or, if possible, increase the stack pipe from diameter DN 100 to diameter DN 150.

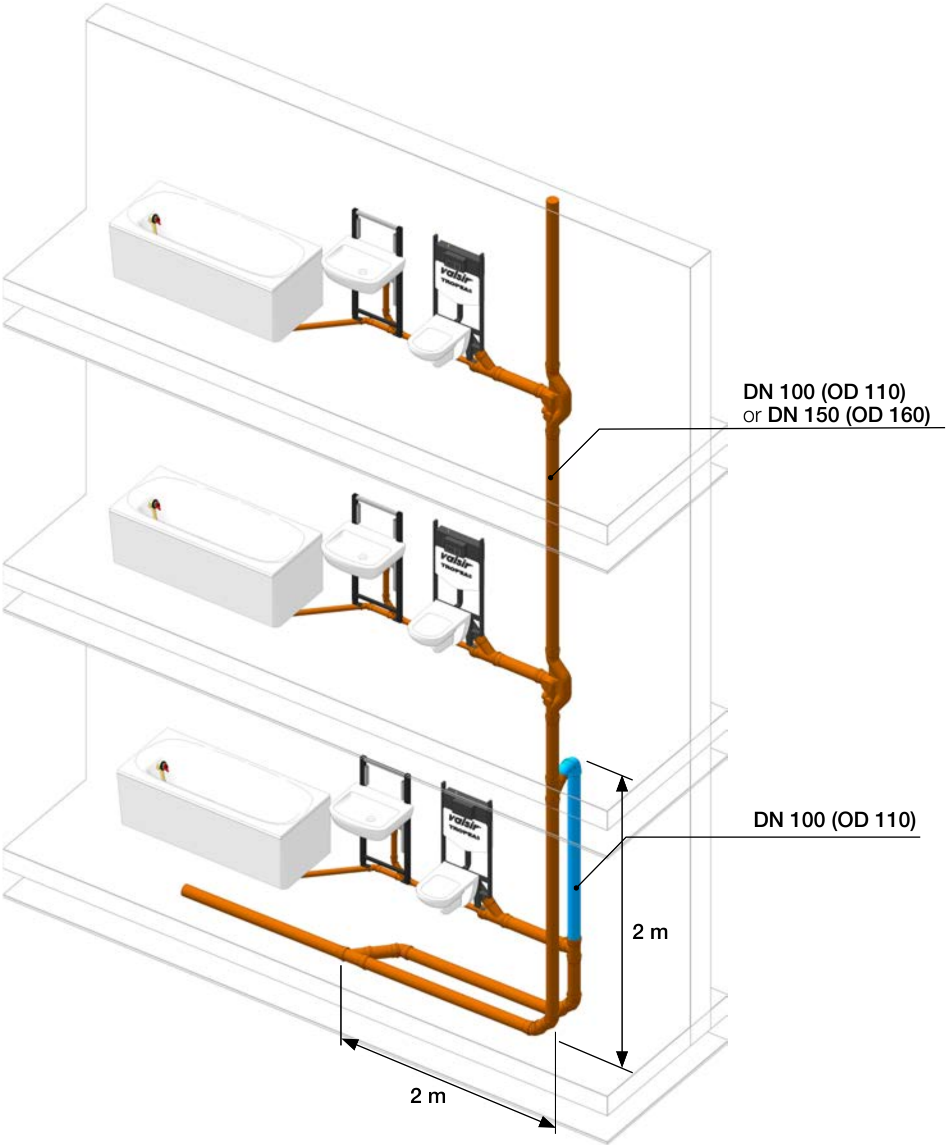
Figure 5.5 Maximum project flow rates are exceeded.



5.3.1 Rules for the foot of the stack in waste systems with ventilation branch fittings

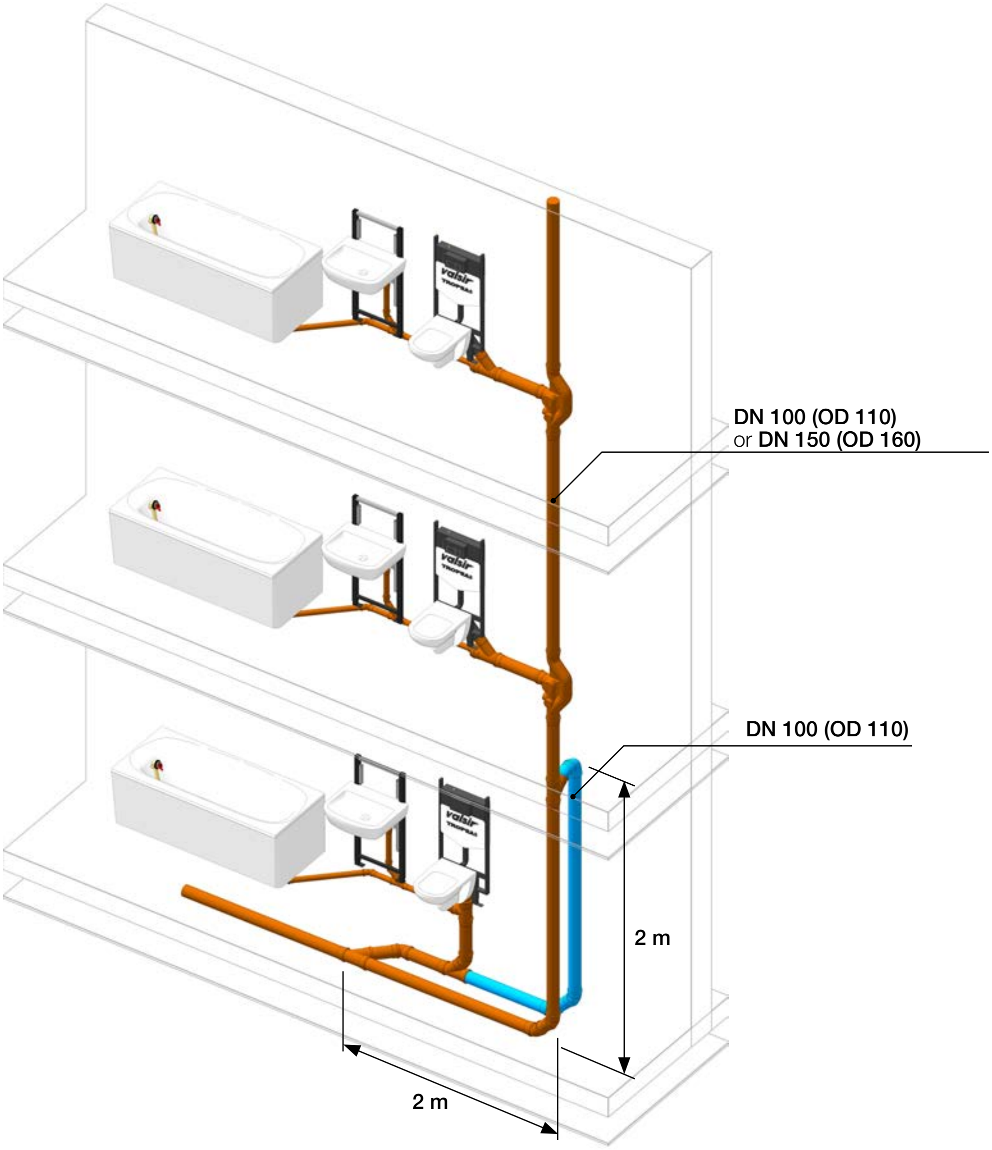
- At the base of the waste stack with ventilation branch fittings, it is mandatory to create a pressure relief loop, that consists of a secondary circuit with a vent loop, having a DN 100 diameter and connected to the primary circuit at no less than 2 m both above and below the stack base. Sanitary fixtures on the same floor of the pressure relief loop must be connected to it using a simple branch; it is not allowed the connection to the main waste stack.

Figure 5.6 Pressure relief loop.



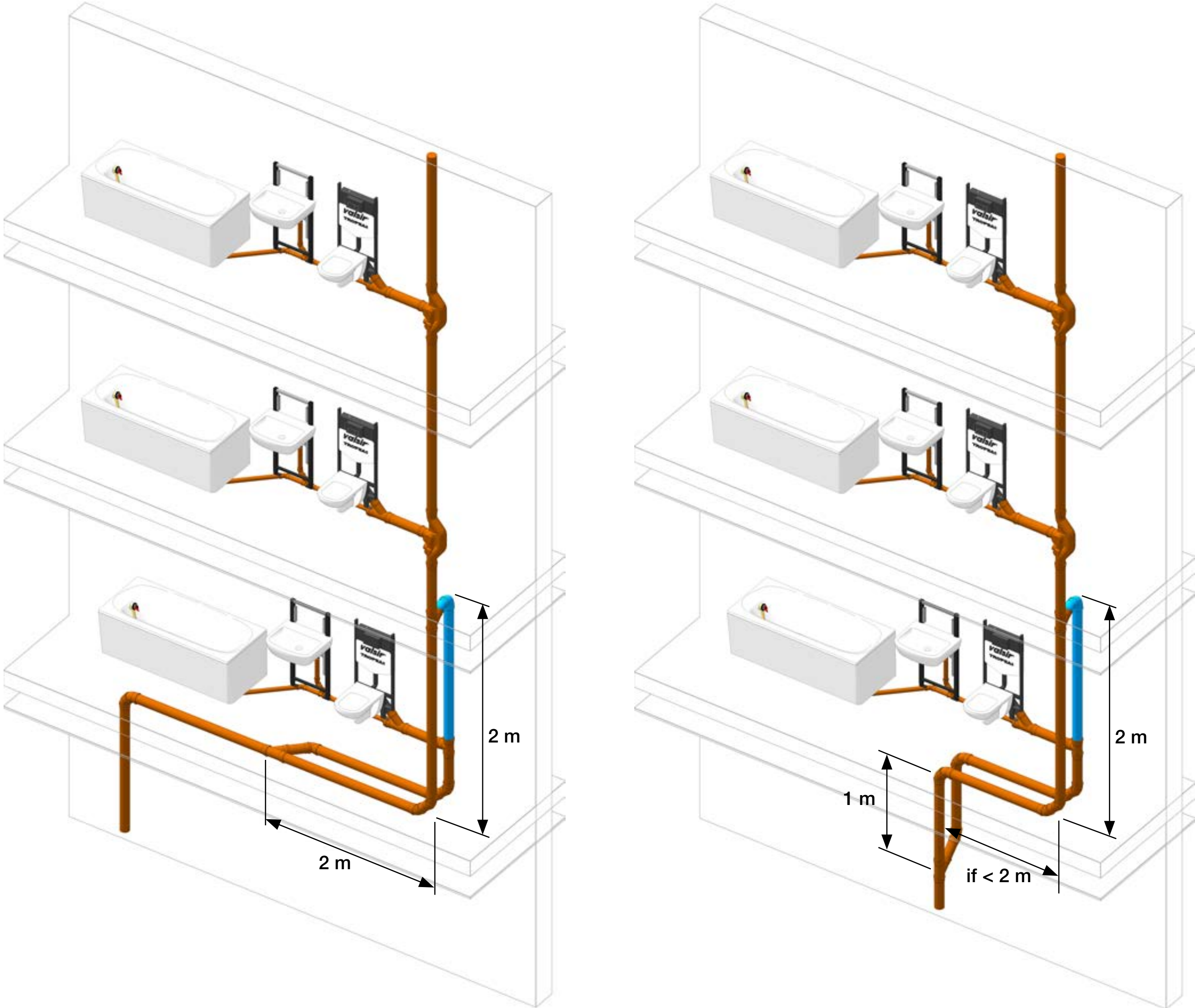
- The sanitary fixtures on the same floor of the pressure relief loop can be connected both to the horizontal or vertical part of the pressure relief loop using a simple branch.

Figure 5.7 Connection of sanitary fixtures to the horizontal section of the pressure relief loop.



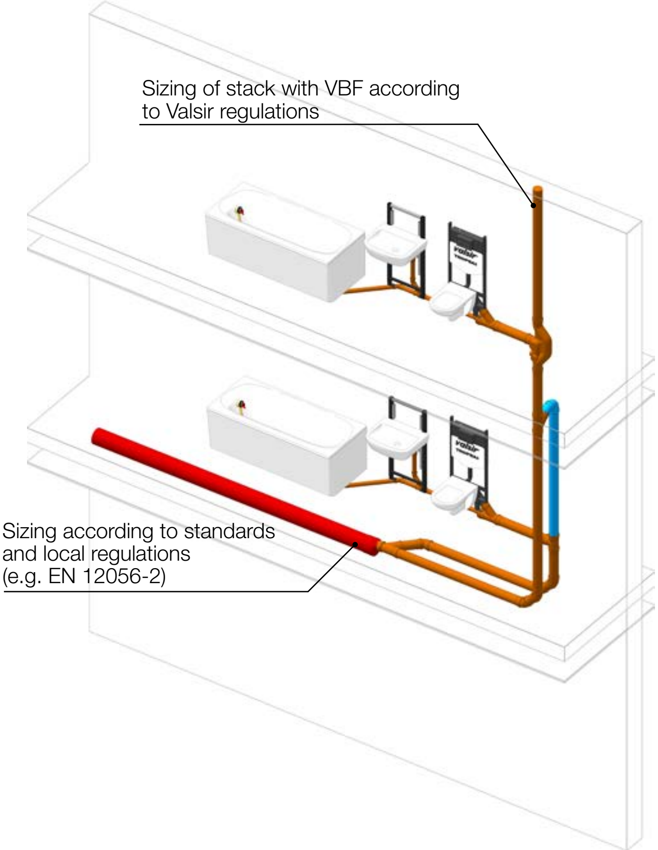
- If it is not possible to create a pressure relief loop with a horizontal pipe of at least 2 m due to an anticipated transition from horizontal to vertical of the primary circuit, it is necessary to extend the pressure relief loop vertically of at least 1 m in the lower part of the system.

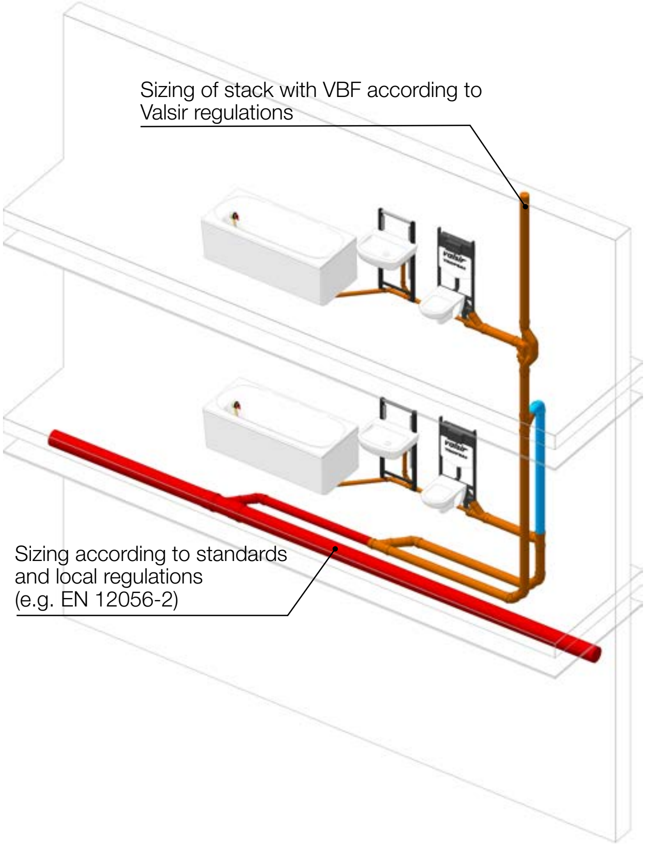
Figure 5.8 Pressure relief loop configurations.

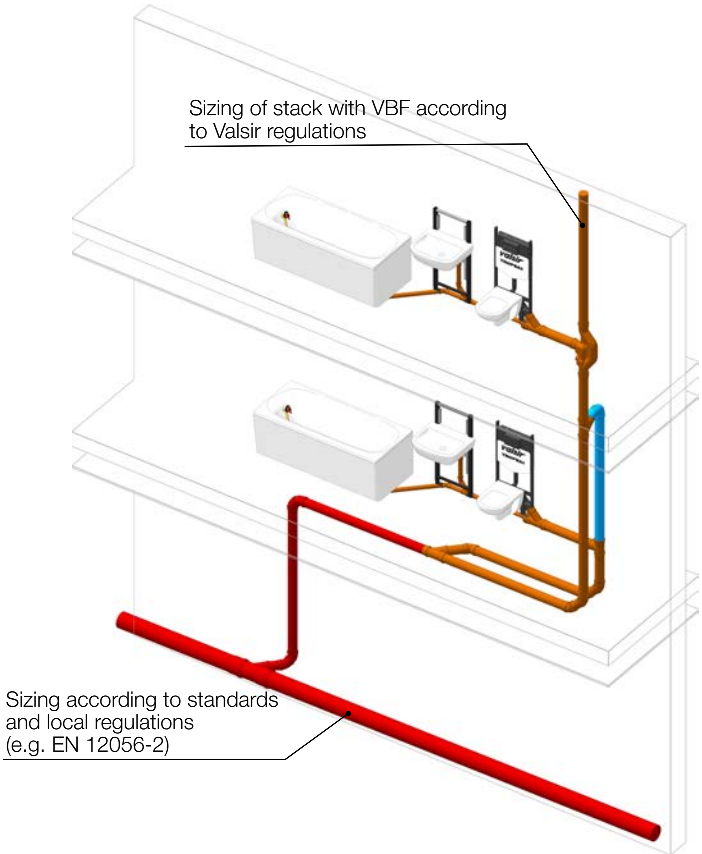


- The base of a soil stack with a ventilation branch fitting must always be provided with a pressure relief loop and the connection to the collector must be made using one of the configurations illustrated in the following figures. The configuration is to be chosen in relation to the position of the collector, the diameter of this must be calculated in compliance with the standards and local regulations (e.g. EN 12056-2).

Figure 5.9 Connection configurations with waste collectors in relation to its position.

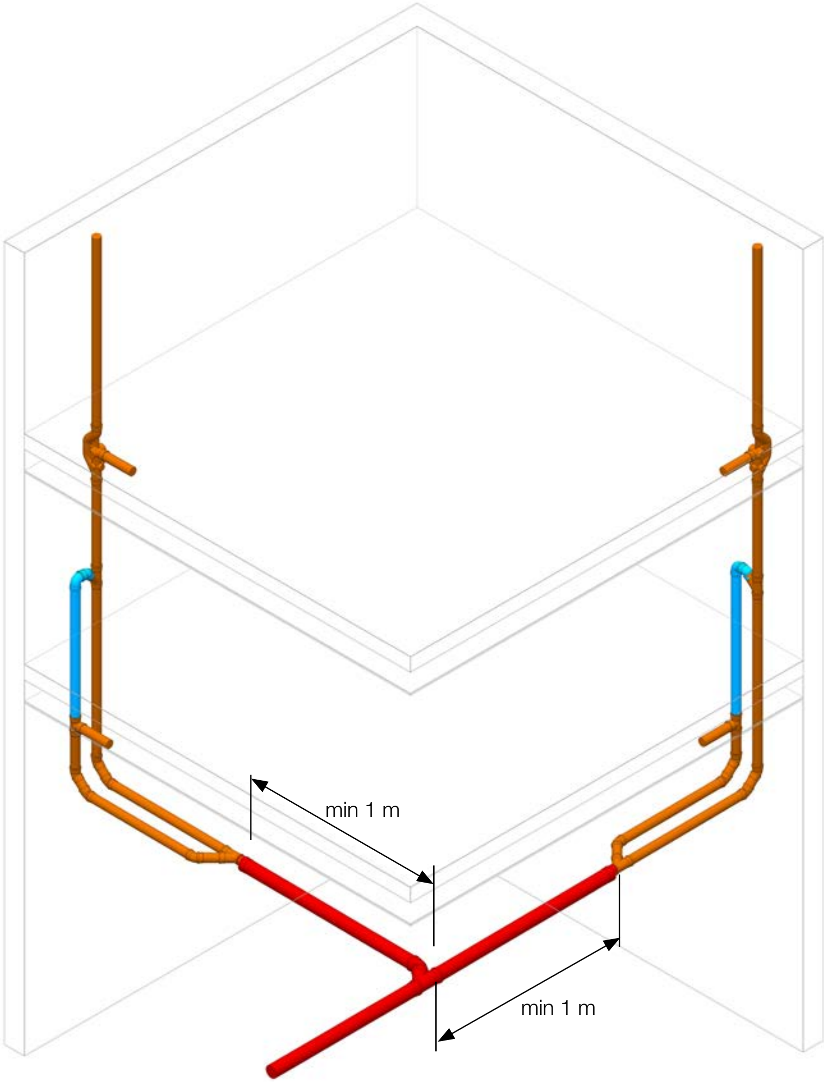






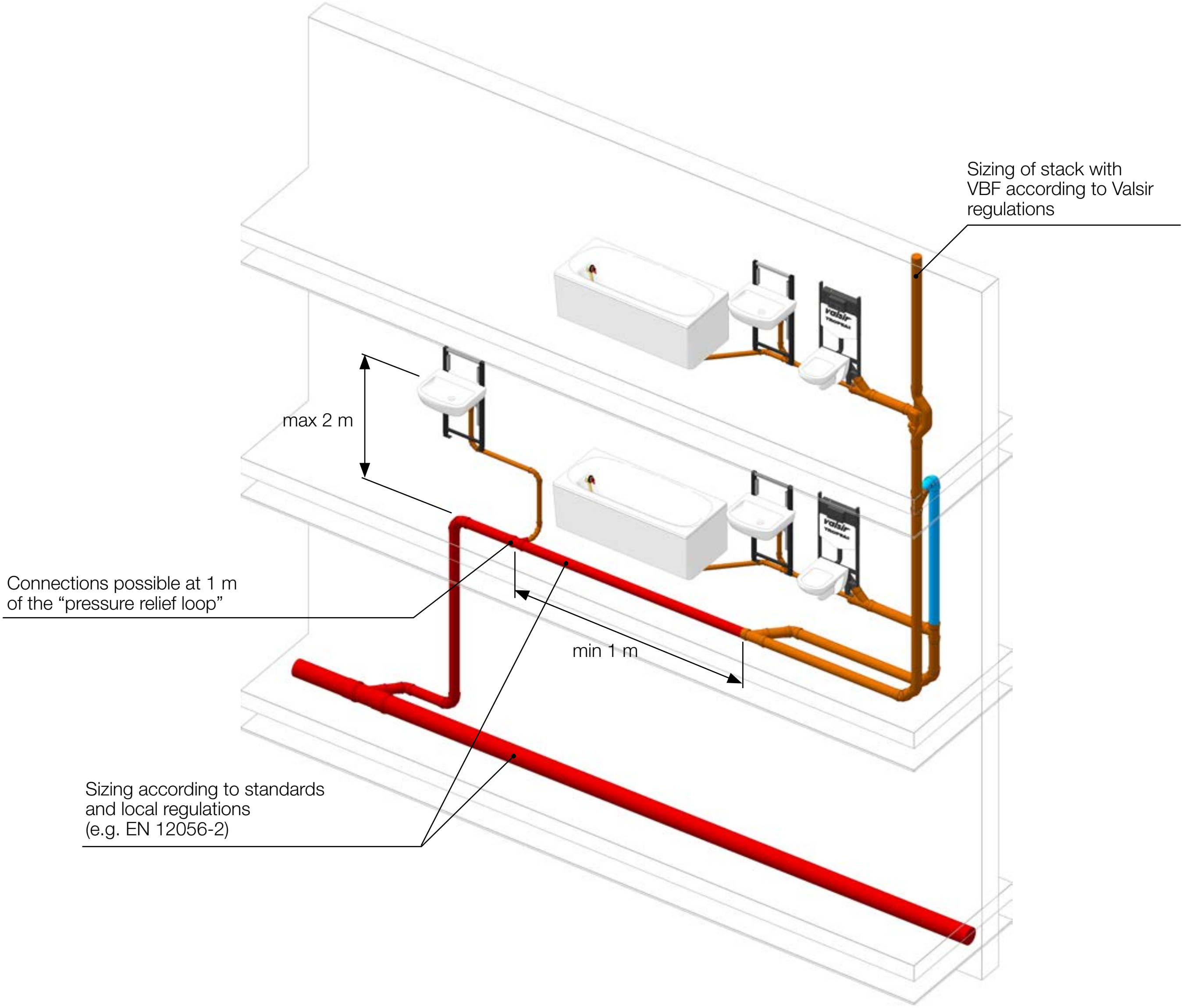
• Several waste stacks equipped with ventilation branch fittings can be drained into the same collector pipe below the respective pressure relief loops, observing a minimum distance of at least 1 m.

Figure 5.10 Connection of several waste stacks to the same collector.



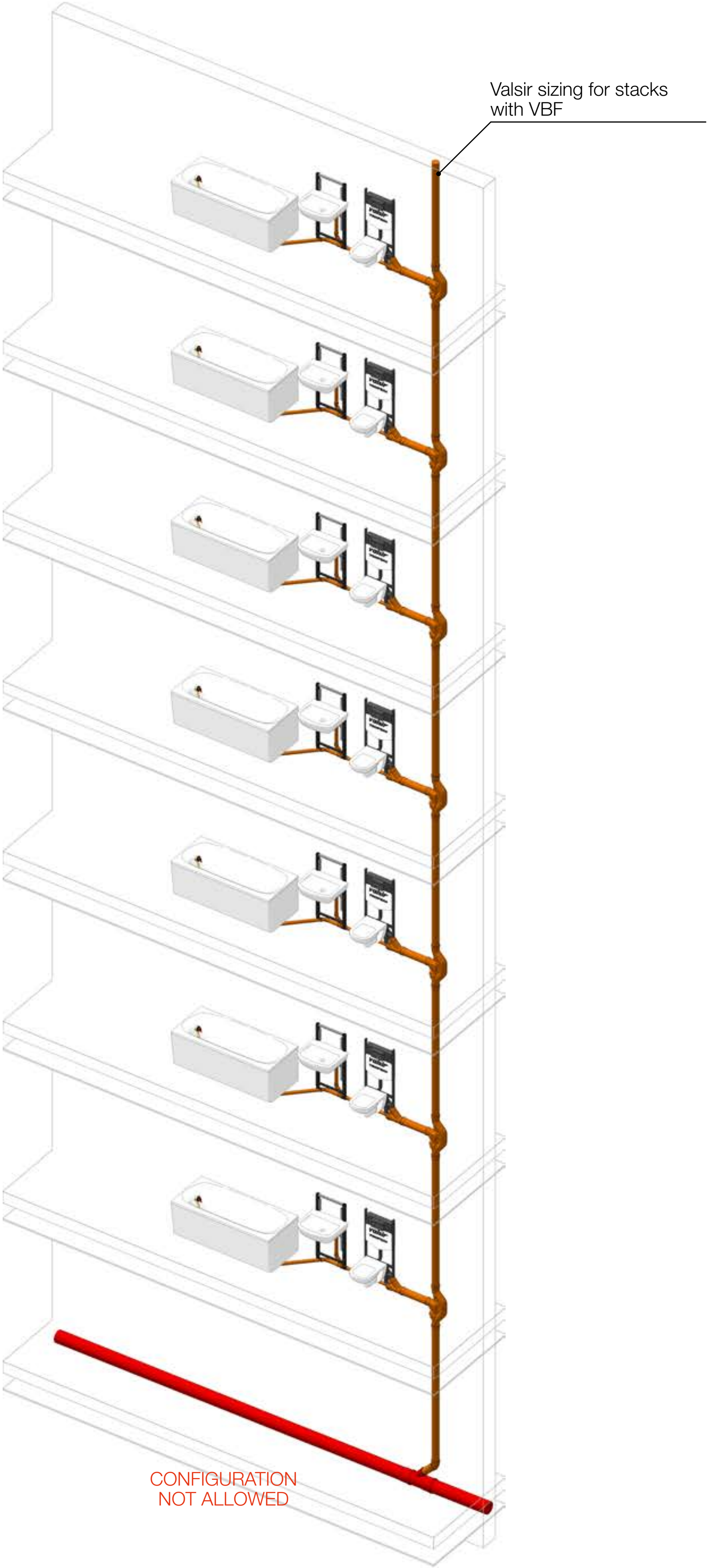
- It is possible to connect more sanitary fixtures, without a dedicated ventilation, on the horizontal pipe after the pressure relief loop only by doing the particular configuration of collector connection and verifying the following conditions:
  1) The flow of these sanitary fixtures must be included in the calculation and verification of the designed maximum flow rate of the waste stack closer to the connection.
  2) The maximum drop between the sanitary fixtures and the collector to which they are connected must be equal to 2 m.
  3) The minimum distance between the connection of sanitary fixtures to the collector and the pressure relief loop must be equal to 1 m.

Figure 5.11 Possible connection zone downstream of the pressure relief loop.



• At the base of a waste stack with ventilation branch fittings is mandatory to create the pressure relief loop.

Figure 5.12 Connection configuration not allowed.



- It is possible to avoid the creation of the pressure relief loop if the following conditions are respected:

1) The total discharge flow Q_{tot} (see equation [4.1]) upstream of the collector or of the direction change must be less than or equal to 5.2 l/s.
2) The maximum distance “h” between the highest and lowest discharge point upstream of the collector or of the horizontal direction change must be less than or equal to 12 m.

To avoid that the pressure negatively influences the sanitary fixtures closer to the stack base, it is necessary to connect them to the waste network in a different way depending on the collector position:

a) If the collector is embedded in the basement floor (or in the floor slab where the direction change is located), the ground floor fixtures (or those of the one above the direction change) can be connected directly to the waste stack by a ventilation branch fitting, because pressure does not influence their performance (see Figure 5.13).

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b) If the collector is ceiling mounted to the basement floor (or to the floor slab where the direction change is located), the ground floor fixtures (or those of the one above the direction change) must be connected to the waste collector to more than 1 m from the base of the waste stack because, in this case, the generated pressure could interfere with their performance (see Figure 5.14).

c)

Figure 5.13 Ventilation branch fittings system without pressure relief loop where the collector is embedded in the basement floor (or in the floor slab where the direction change is located).

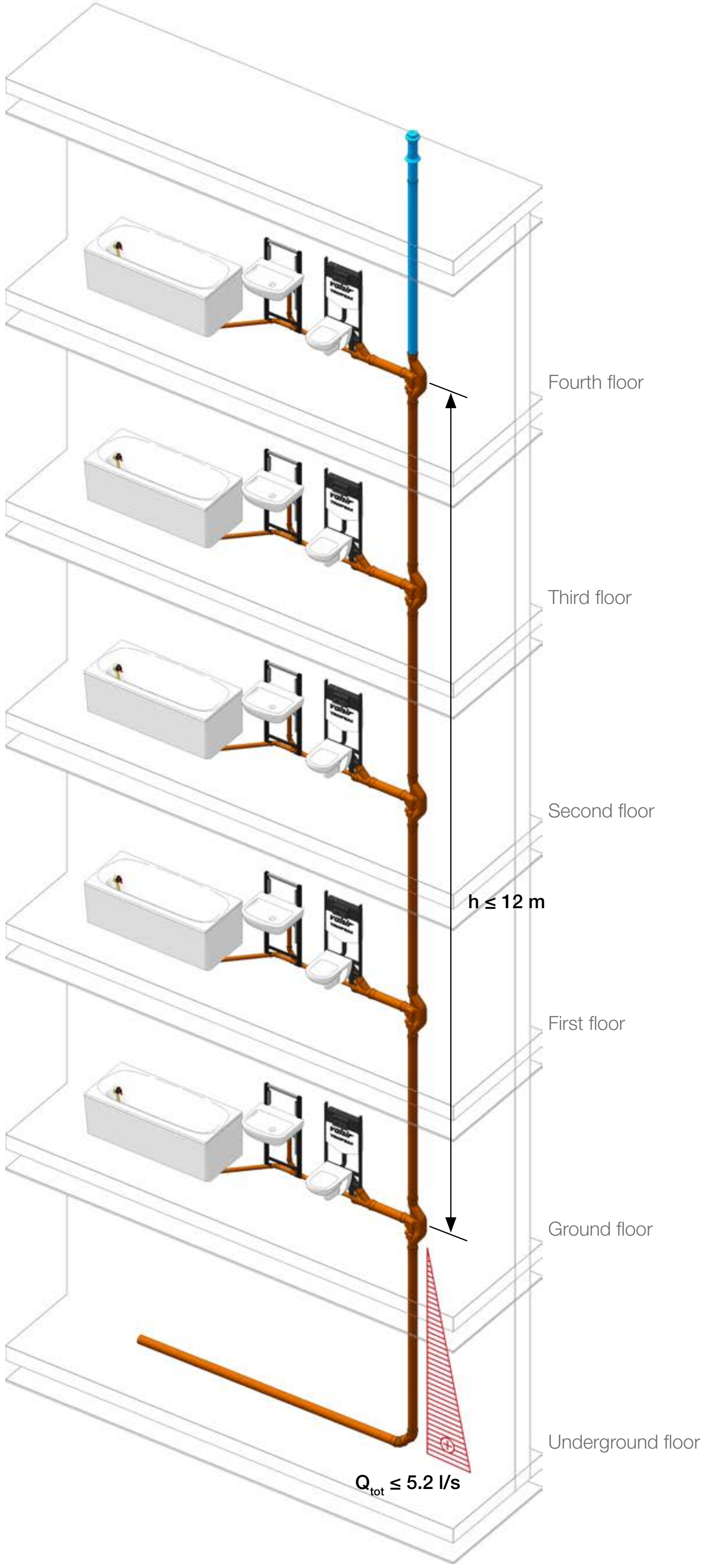

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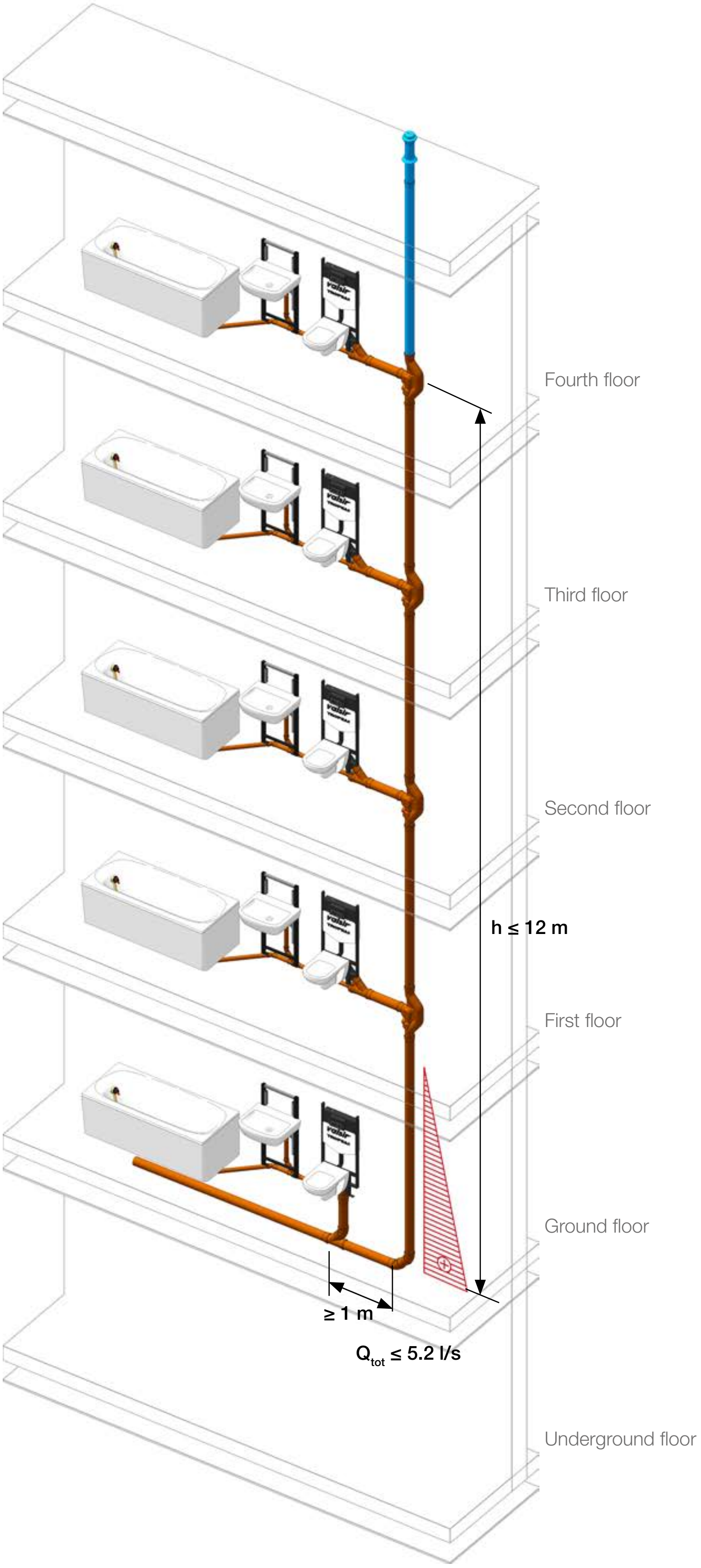
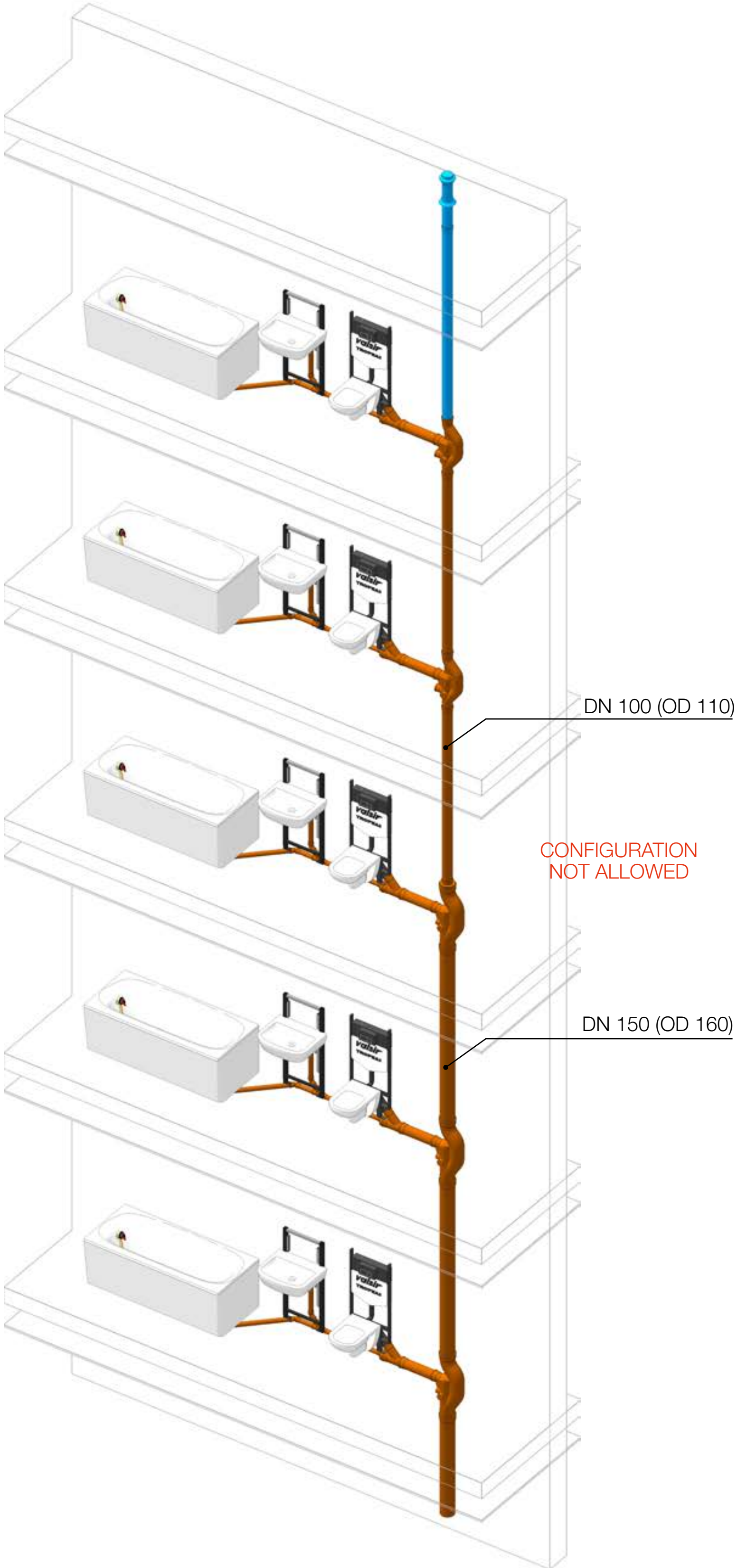
Figure 5.14 Ventilation branch fittings system without pressure relief loop where the collector is ceiling mounted to the basement floor or to the floor slab where the direction change is located.



5.3.2 Rules governing waste stacks with ventilation branch fittings

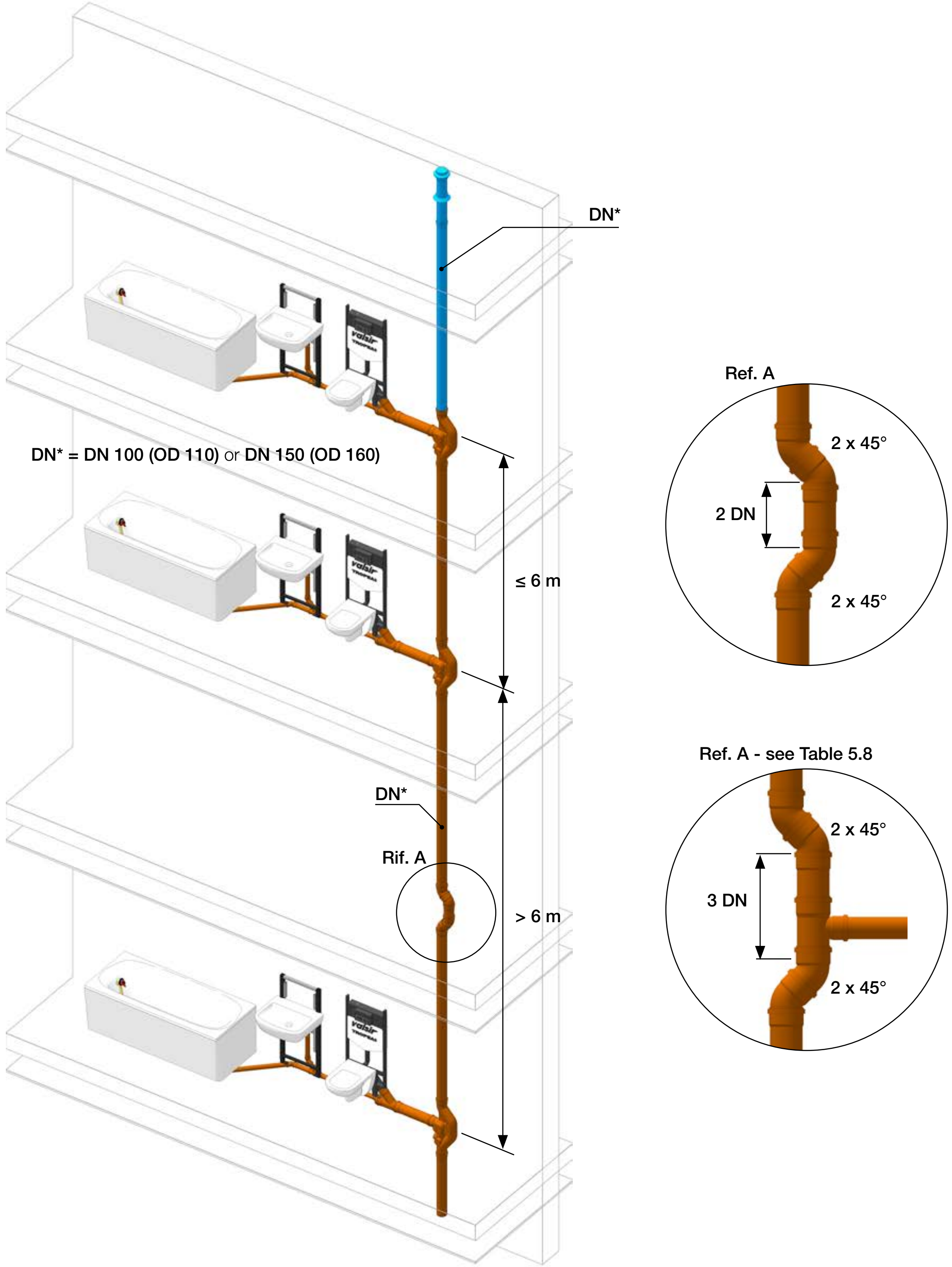
- Waste stacks must be installed using the same diameter; DN 100 branches can therefore not be used together with DN 150 branches within the same waste stack.

Figure 5.15 Unauthorized configuration of waste stack with ventilation fittings.



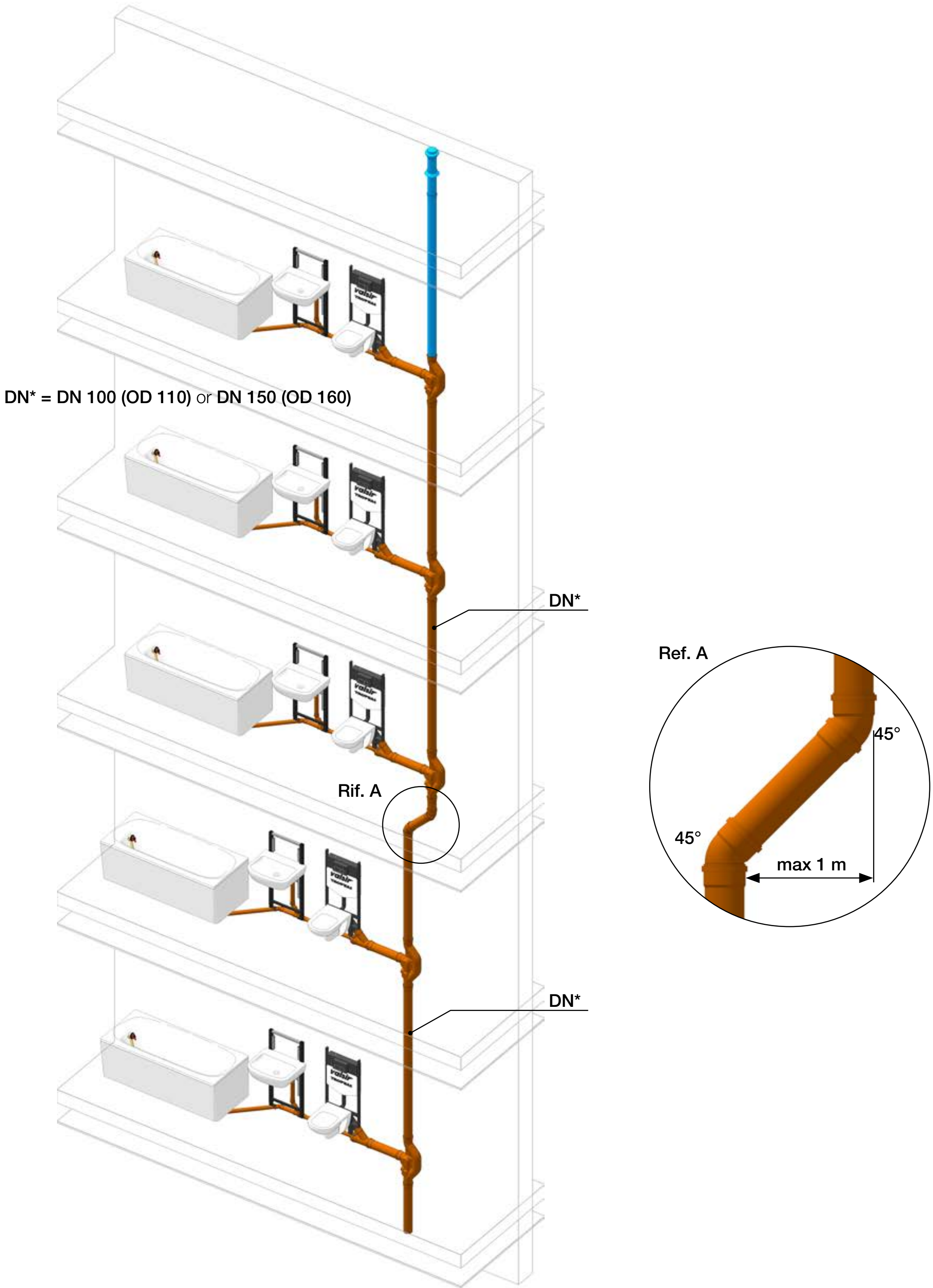
- The maximum distance between two ventilation branch fittings must not exceed 6 m. If this is not possible then a double offset must be placed in the downpipe, i.e. an offset is created using two 45° bends followed by a vertical pipe with a length equal to twice the stack diameter (therefore, for DN 100 stacks, the length is 200 mm, for DN 150 stacks it is 300 mm), followed once more by two 45° bends. This offset works as a speed breaker thus guaranteeing the correct working of the waste system. No sanitary fixtures can be connected to the vertical pipe between the 45° bends unless the length is increased to 3 times the diameter of the stack (for DN 100 stacks it is 300 mm, for DN 150 it is 450 mm).

Figure 5.16 Maximum distance between ventilation branch fittings.



- If a stack offset needs to be made with a length of less than 1 m, two 45° bends shall be used as illustrated in the figure.

Figure 5.17 Stack offset shorter than 1 m.



- If stack offsets greater than 1 m are needed, they must be provided with a pressure relief loop in the vertical to horizontal transition area, unless the conditions indicated in the Figure 5.13 and Figure 5.14 are respected. Moreover, the geometrical and hydraulic criteria indicated in the following tables must be respected.
- The base of the stack must not be considered as an offset if there is no further vertical pipe equipped with waste connections.

Table 5.3 Geometrical sizing criteria for stack offsets longer than L > 1 m.

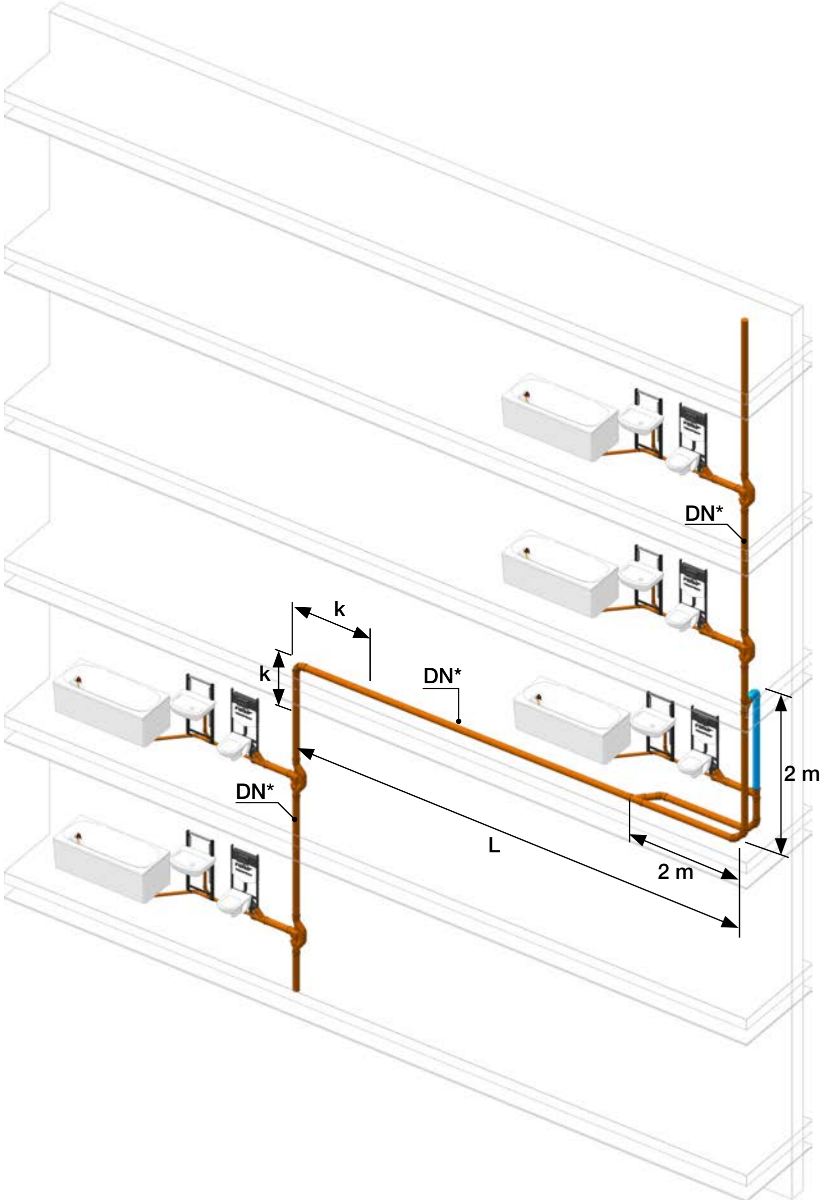
Characteristics of the horizontal section of the offset	Length K of the joint-free zone	Allowed gradient on horizontal section	Further ventilation of horizontal section
L < 10 m	0.5 m	0.5% ÷ 5%	No
L ≥ 10 m	2 m	1% ÷ 5%	Yes

Table 5.4 Hydraulic sizing criteria for stack offsets longer than L > 1 m.

Characteristics of the stack	Hydraulic test*
L < 10 m	No other hydraulic test besides the one required for a system without deviation
L ≥ 10 m	In the stack before the direction change and in the horizontal tract, it must be: $Q_{ww, max} \leq$ 6.0 l/s (∑DU ≤ 144 l/s) for stack OD 110 $Q_{ww, max} \leq$ 12.2 l/s (∑DU ≤ 595 l/s) for stack OD 160

* In any case, the hydraulic testing rules required for stacks without deviations are to be applied.

Figure 5.18 Stack offsets longer than 1 m.



If there are more than one stack offset greater than 1 m within the same waste stack, it is necessary to make sure that the total waste flow Q_{tot} of all the sanitary fixtures upstream of each direction change is lower or equal to 5.2 l/s. Furthermore, it must be verified the distance “h” between the highest and lowest discharge point of each vertical part included within the offsets. If the distance is lower than 12 m, the creation of the pressure relief loop is not necessary.
Every stack offset must be considered independently from any of the other present within the waste stack. Consequently, if there are one or more offset where the conditions mentioned above are verified, it is possible to avoid the creation of the pressure relief loop in correspondence of these offsets, even if on the same stack are present offsets where these conditions are not respected; in these last cases, the pressure relief loop must be created. See Figure 5.19 and Figure 5.20 for two explicative cases.

Figure 5.19 Example of pressure relief loop with multiple stack offset with a 0.5 contemporaneity coefficient.

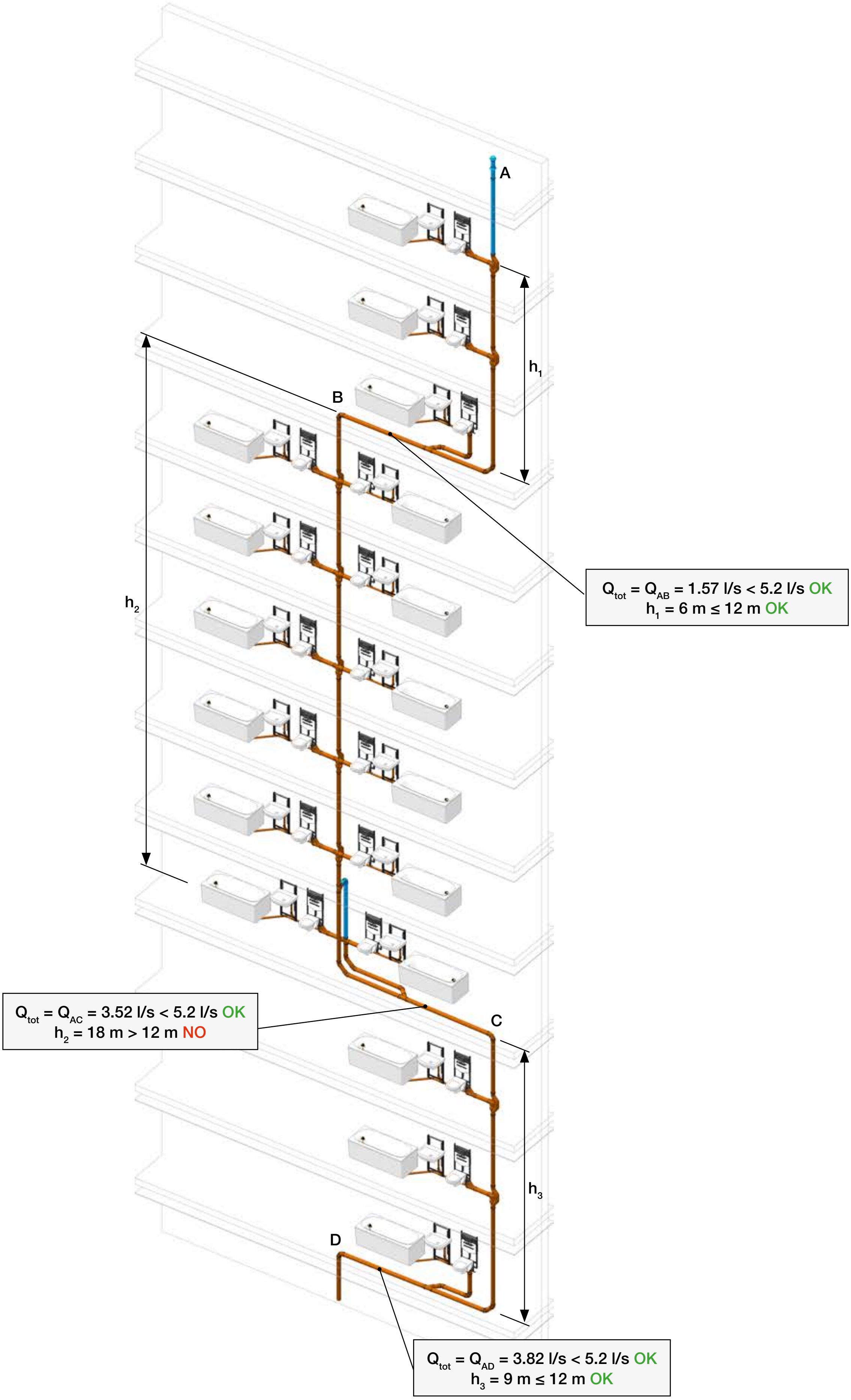


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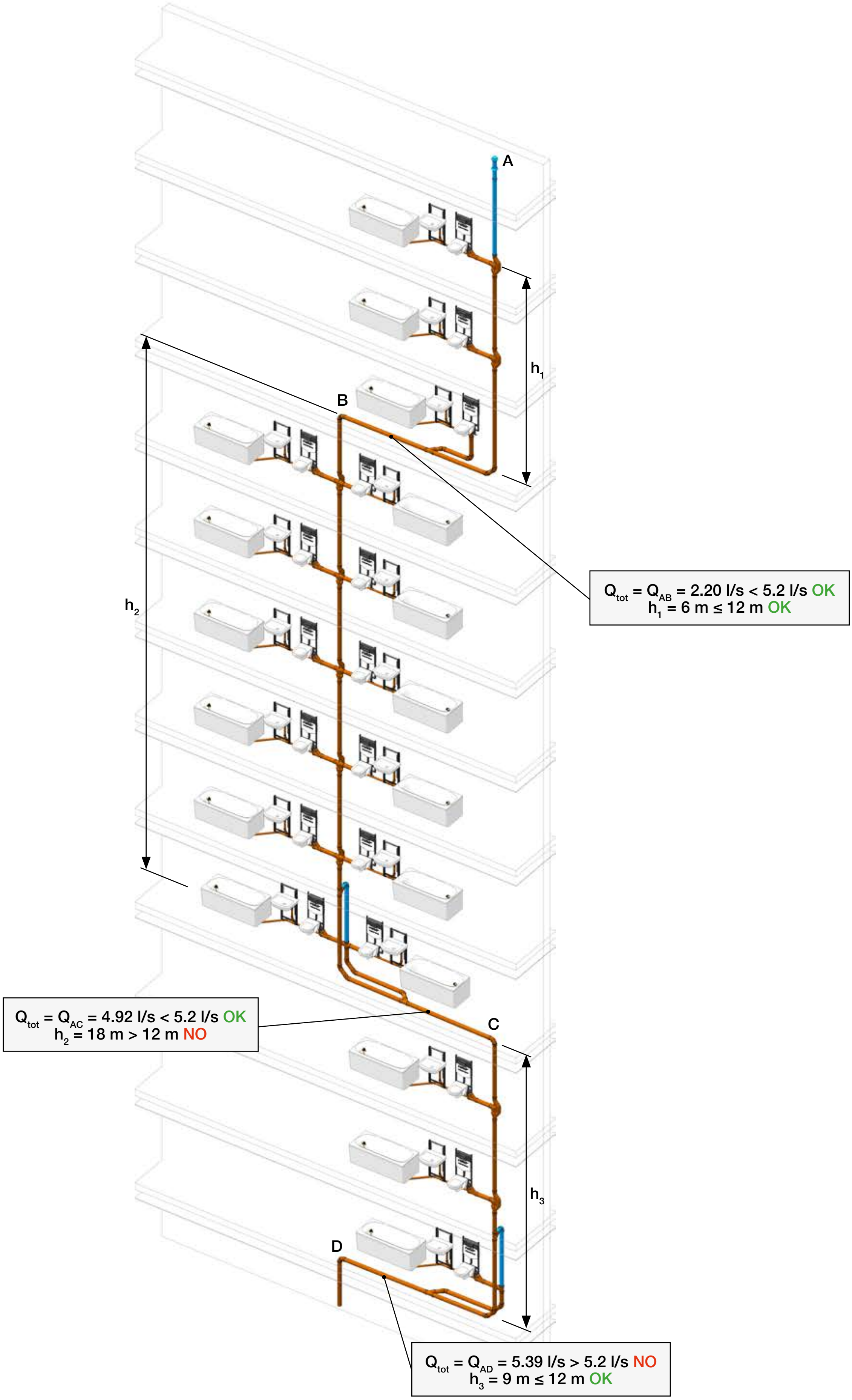
Figure 5.20 Example of pressure relief loop with multiple stack offset with a 0.7 contemporaneity coefficient.



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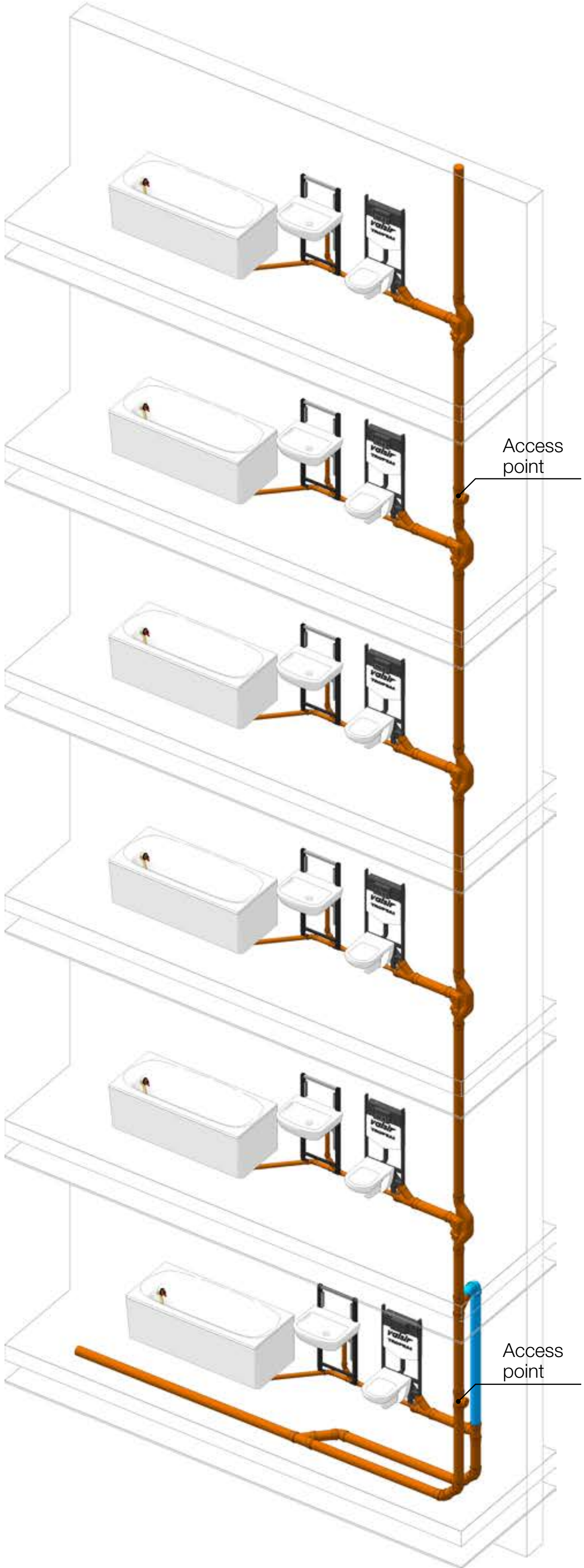
• In conjunction with the pressure relief loop, at least every 5 storeys, it is recommended the installation of an access fitting.

Figure 5.21 Position of access fittings.



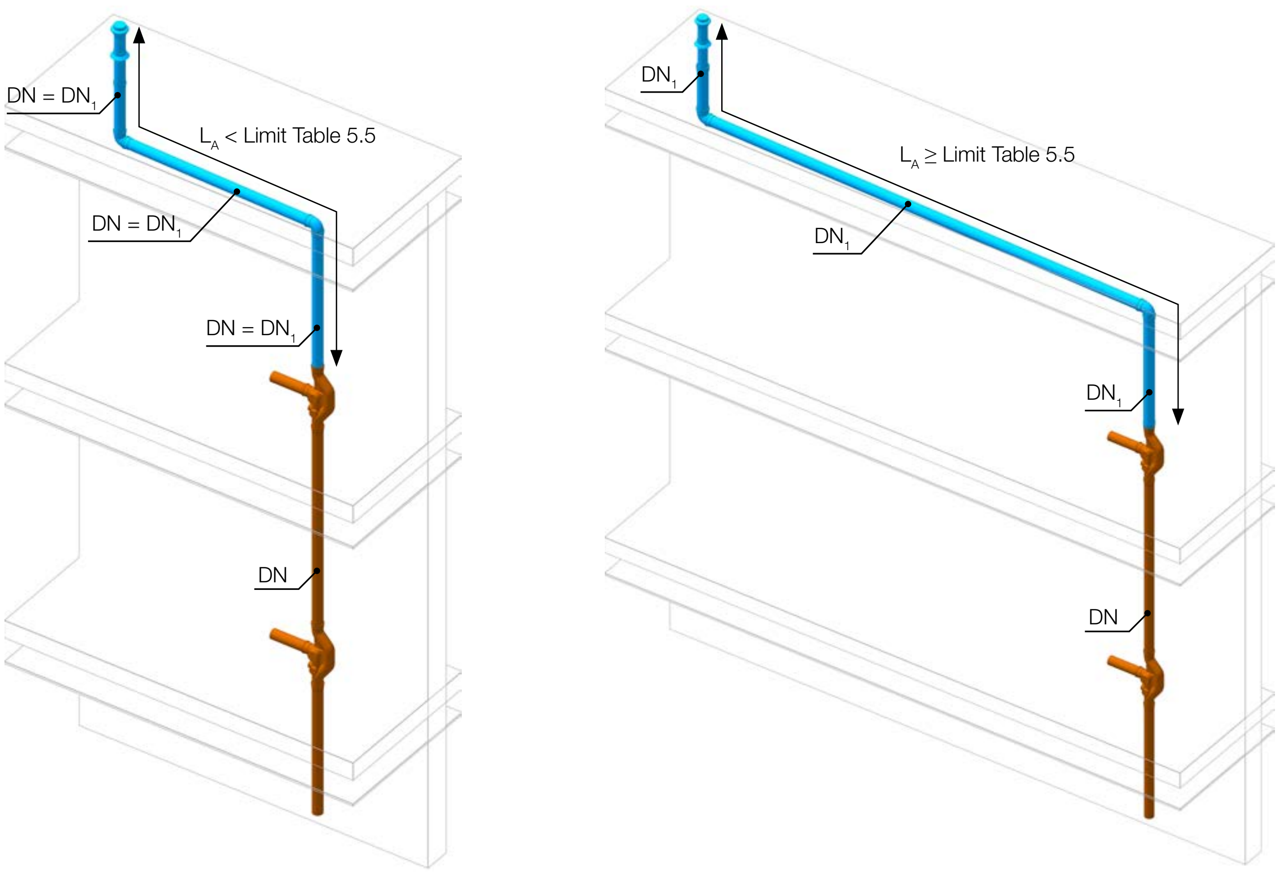
5.3.3 Rules for the ventilation of soil stacks with ventilation branch fittings

- The soil stack must always terminate at the roof with no reductions in diameter.
- Membrane aerators (ventilation valves) should not be used in this type of waste system as they would not guarantee the required flow of air for ventilation and would not be capable of eliminating any excess pressure inside the network.
- In case an offset is needed in the ventilation part of the system, consider the segment L_A between the vent cowl on the roof and the tallest branch connection (see Figure 5.22), and check the length of such segment as per the following table.

Table 5.5 Increase in diameter of the ventilation stack in the event of displacement.

Diameter of the soil stack DN (OD) [mm]	Deflection [m]	Diameter of the horizontal segment and of the roof terminal DN_1 (OD_1) [mm]
100 (110)	< 6	100 (110)
	≥ 6	125 (125)
150 (160)	< 6	150 (160)
	≥ 6	200 (200)

Figure 5.22 Configuration of the displacement of the ventilation stack.



- Just like for the other types of ventilation systems (primary and parallel), it is possible to merge the ventilation stacks in a single ventilation collector with a minimum slope of 0.5% in order to discharge condensation.

In the event that more than one stack needs to be connected to one single ventilation collector, the following rules should be followed:

1) The ventilation segments must be sized based on the total flow rate detected at the bottom of the stack, following Table 5.6.
2) In the ventilation part, from the stacks towards the roof, the collectors cannot be reduced in size.

Table 5.6 Maximum flow for the sizing of the pipe segments of a ventilation collector.

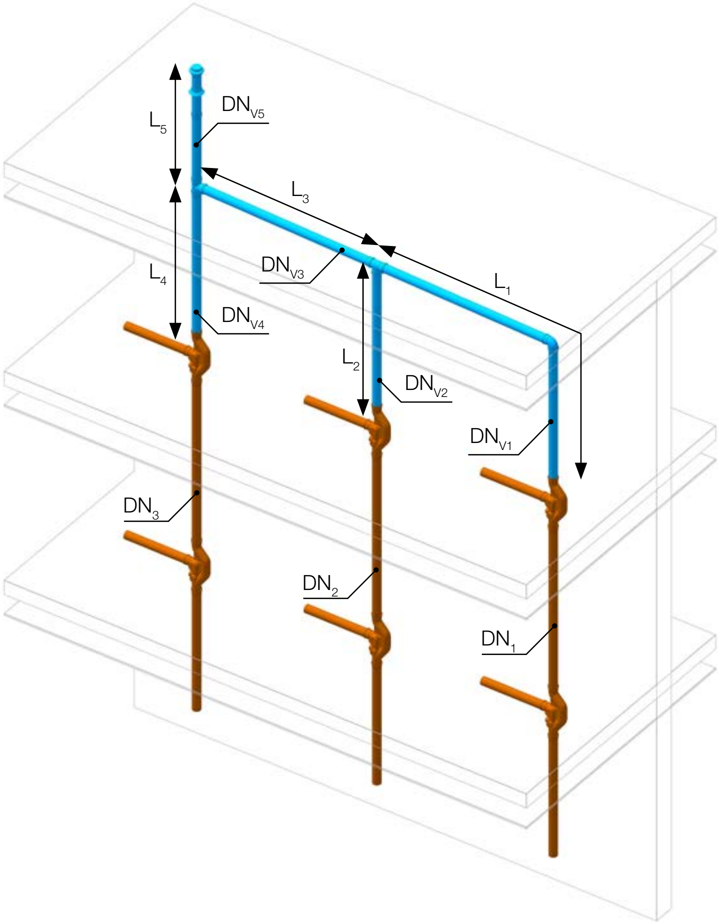
Diameter of the ventilation segment ∑DU [l/s]	Maximum flow DN [mm]
200	100
310	125
850	150
2120	200
5170	250
13070	315

3) Once the ventilation segments have been sized according to the flow rate they need to handle, verify by means of the Table 5.7 if is necessary to increase the pipe diameter based on the length of each single segment.

Table 5.7 Pipe diameter increase in case of ventilation collector.

Diameter DN (OD) as per sizing Table 5.6 [mm]	Segment length [m]	Diameter DN_v (OD_v) to be used [mm]
100 (110)	< 11	100 (110)
	≥ 11	125 (125)
125 (125)	< 13	125 (125)
	≥ 13	150 (160)
150 (160)	< 16	150 (160)
	≥ 16	200 (200)
200 (200)	< 20	200 (200)
	≥ 20	250 (250)
250 (250)	< 25	250 (250)
	≥ 25	300 (315)
300 (315)	< 32	300 (315)

Figure 5.23 Configuration of the ventilation collector.



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5.3.4 Rules for branch pipes with ventilation branch fittings

- The branch pipe must be sized in accordance with the criteria established by the regulations in force and the local standards.
- The maximum length for an unvented branch pipe is 8 m, this must be reduced to 6 m in the presence of a water closet (in DN 100 connections). The minimum gradient allowed is 1%, maximum 5%. (Figure 5.24).
- If the branch pipes are ventilated the maximum length is 20 m for all connections. The minimum gradient allowed is 0.5%, maximum 5%. (Figure 5.25).
- If ventilation of the branch pipes is required, the ventilation circuit must be connected to the waste stack with a 45° branch fitting.

Figure 5.24 Branch pipe without ventilation.

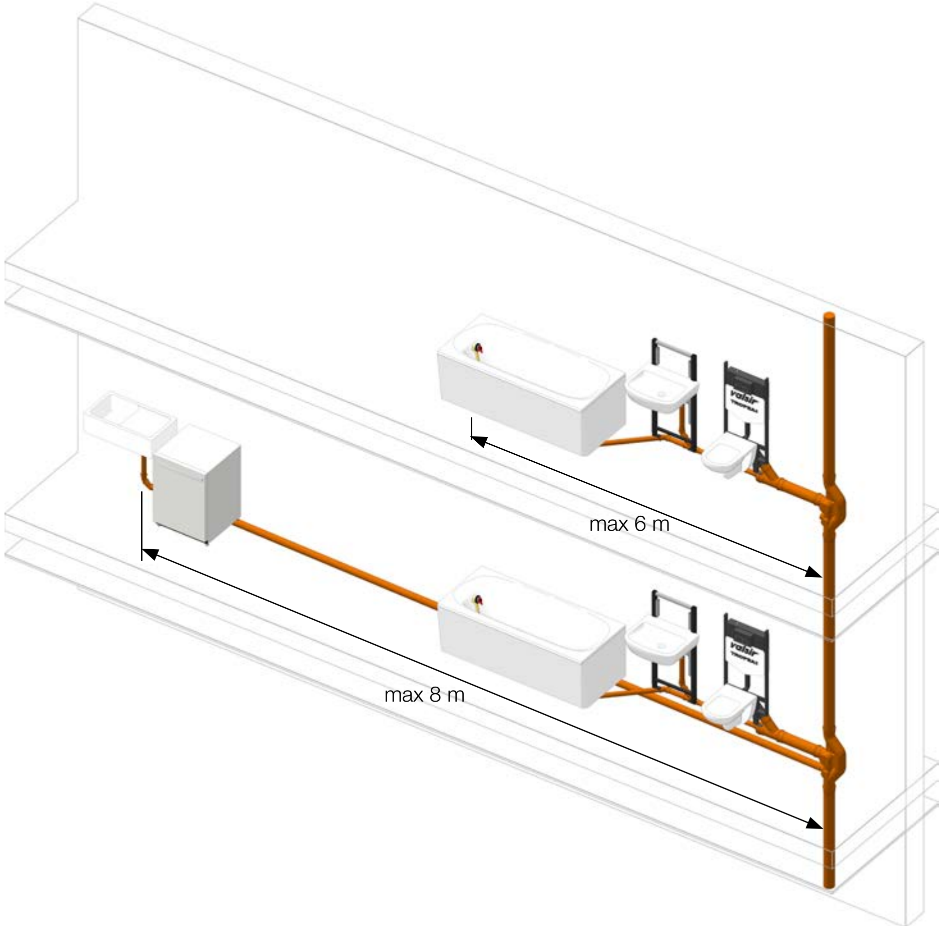
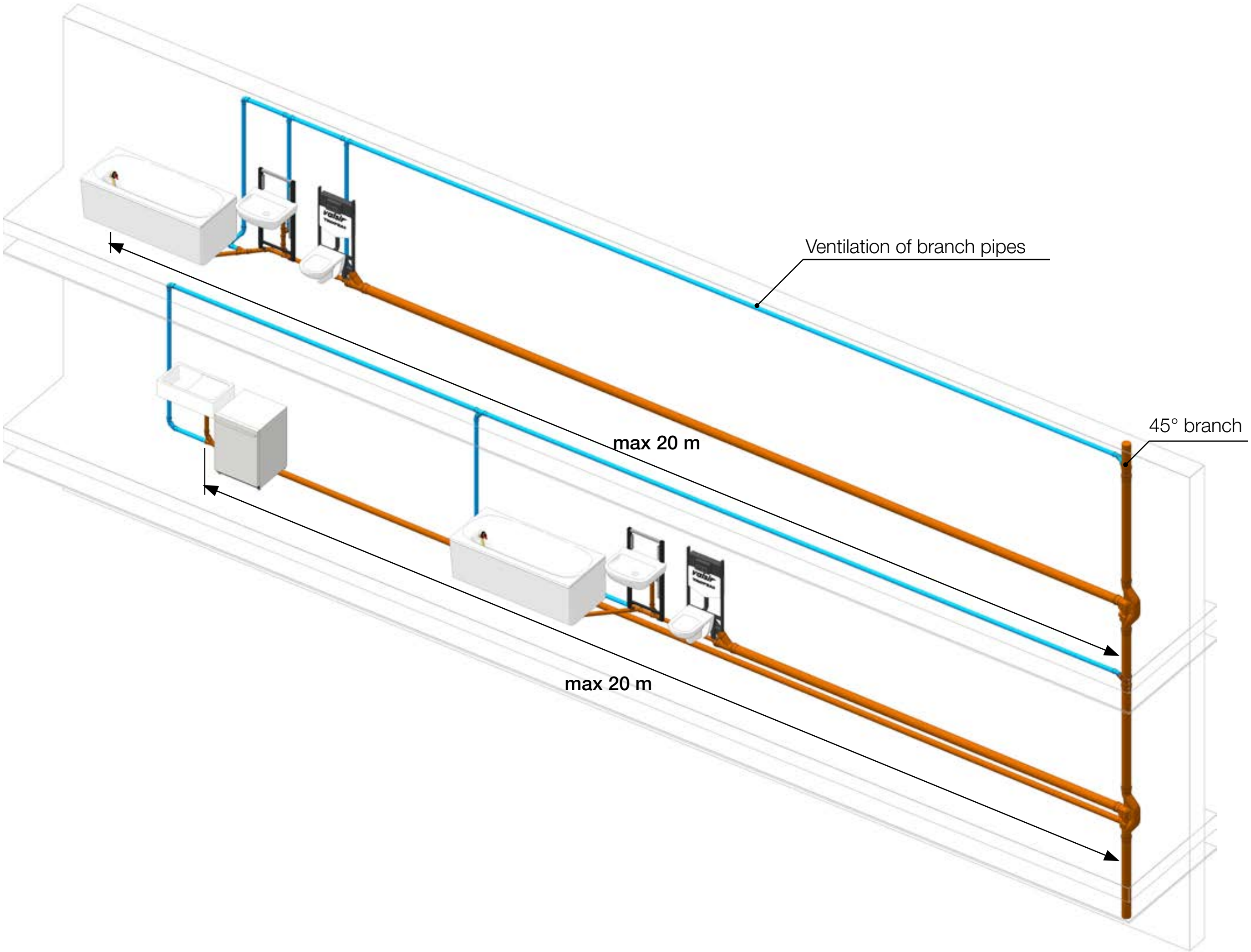


Figure 5.25 Branch pipe with ventilation.

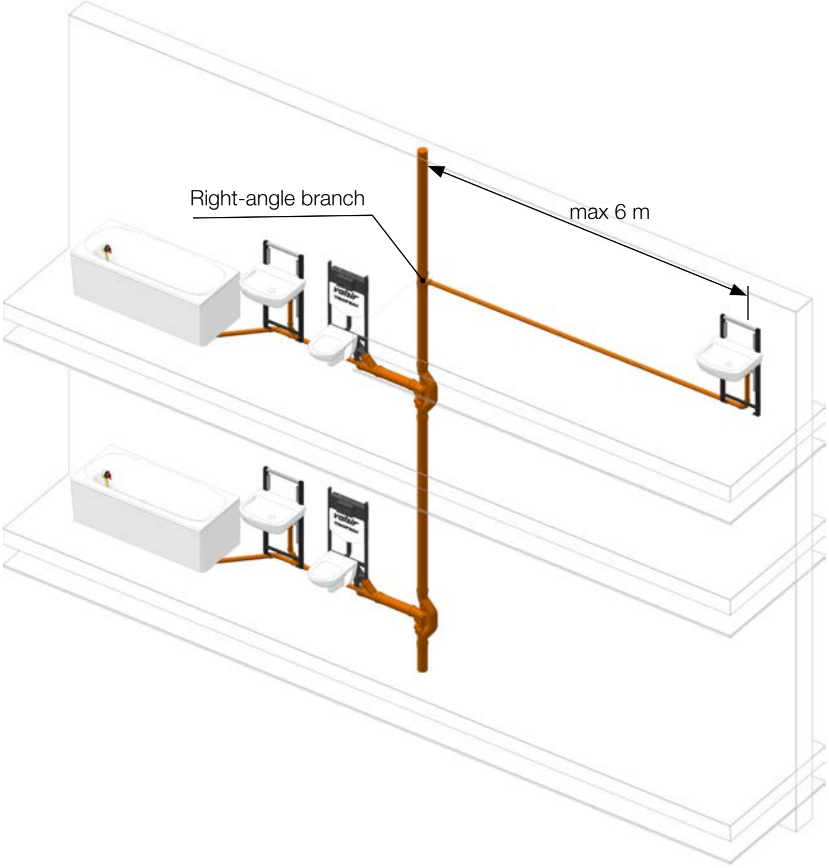


- Each branch pipe is connected to the waste stack using the ventilation branch fitting; if necessary, the branch pipe can be connected directly to the stack with a right-angle branch, as long as the length does not exceed 6 m and the maximum diameters indicated in the table are observed. A water closet cannot be connected to these branch pipes. (Figure 5.26).

Table 5.8 Maximum diameter of branch pipes connected directly to the stack.

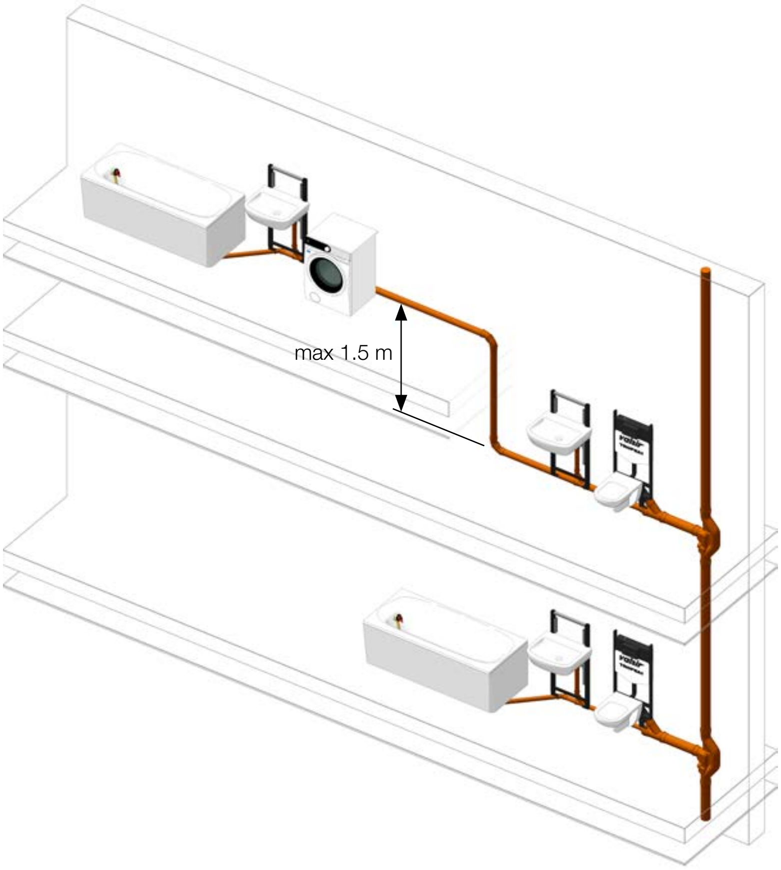
Diameter of stack	Maximum diameter of branch pipe
DN 100 (OD 110 mm)	DN 60 (OD 63 mm)
DN 150 (OD 160 mm)	DN 100 (OD 110 mm)

Figure 5.26 Branch pipes connected with right-angle branch.



- If a vertical transition of the branch pipe is necessary, the maximum height allowed is 1.5 m.

Figure 5.27 Vertical transition of a branch pipe.

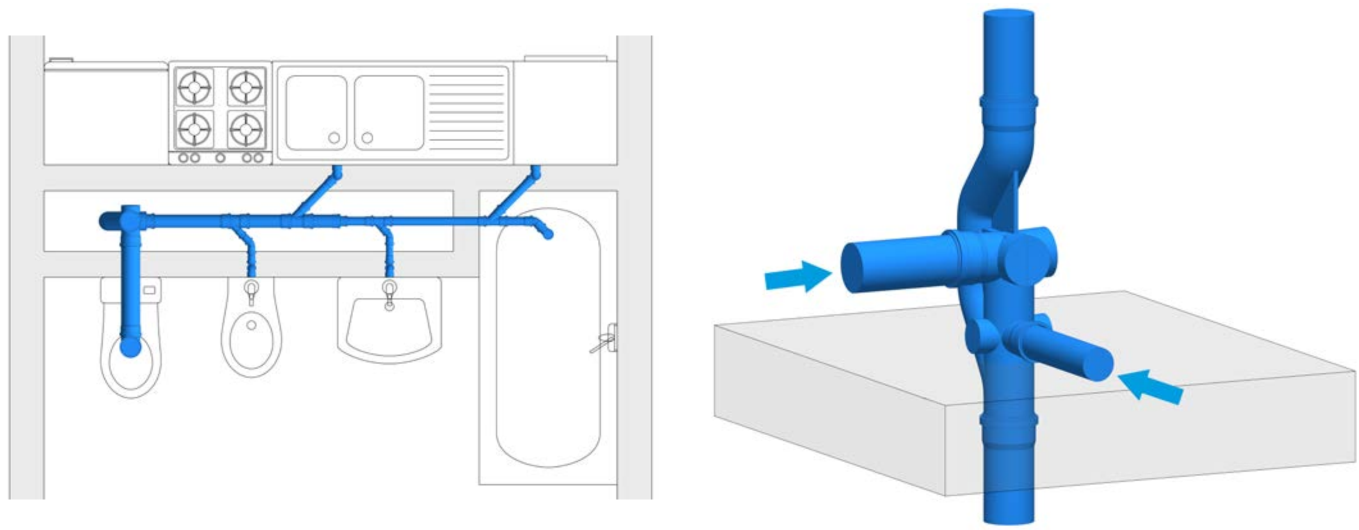


5.4 Sizing examples

Example 1. Waste system with ventilation branch fitting
A waste stack must serve a 25 storeys building; verify the possibility of installing a system using DN 100 ventilation branch fittings connected to each floor as illustrated in Figure 5.28.
Each floor consists of:

- 1 WC with 9 litres cistern
- 1 bidet
- 1 bathtub
- 1 washbasin
- 1 sink
- 1 washing machine 6 kg

Figure 5.28 Bathroom and kitchen plan.



Flow calculation

Table 4.4 can be used to calculate the total flow rate for each sanitary fixture that drains into the ventilation branch fitting connections.

Table 5.9 Flows conveyed into ventilation branch fitting.

Sanitary fixture	Quantity	DU [l/s]	∑ DU [l/s]	Branch connection	Flow conveyed into connections [l/s]
WC with 9 litres cistern	1	2.5	2.5	DN 100	2.5
Bathtub	1	0.8	0.8		
Bidet	1	0.5	0.5		
Washbasin	1	0.5	0.5	DN 70	3.4
Sink	1	0.8	0.8		
Washing machine 6 kg	1	0.8	0.8		
Total					**5.9**

It is clearly verified that the limit on the flows entering the ventilation branch fitting (set out in chapter 5.3) is respected:

Table 5.10 Compliance with project load of ventilation fitting.

Capacity of ventilation branch fitting	Maximum flow rate $\sum DU_{max}$ [l/s]	Calculated flow rate $\sum DU$ [l/s]	Compliance
Maximum flow in the ventilation branch fitting	25	5.9	Yes

Verification of the waste stack

5

Having ascertained that the connections of the ventilation branch fitting can deal with the required flows, a final verification is conducted to check that the flow conveyed into the stack complies with the maximum load of 13.0 l/s (for DN 100 ventilation fitting).

The total flow is:

$$\sum DU = 25 \cdot 5.9 = 147.5 \text{ l/s} \quad [5.1]$$

and hence the project flow, given by the equation [4.3], is:

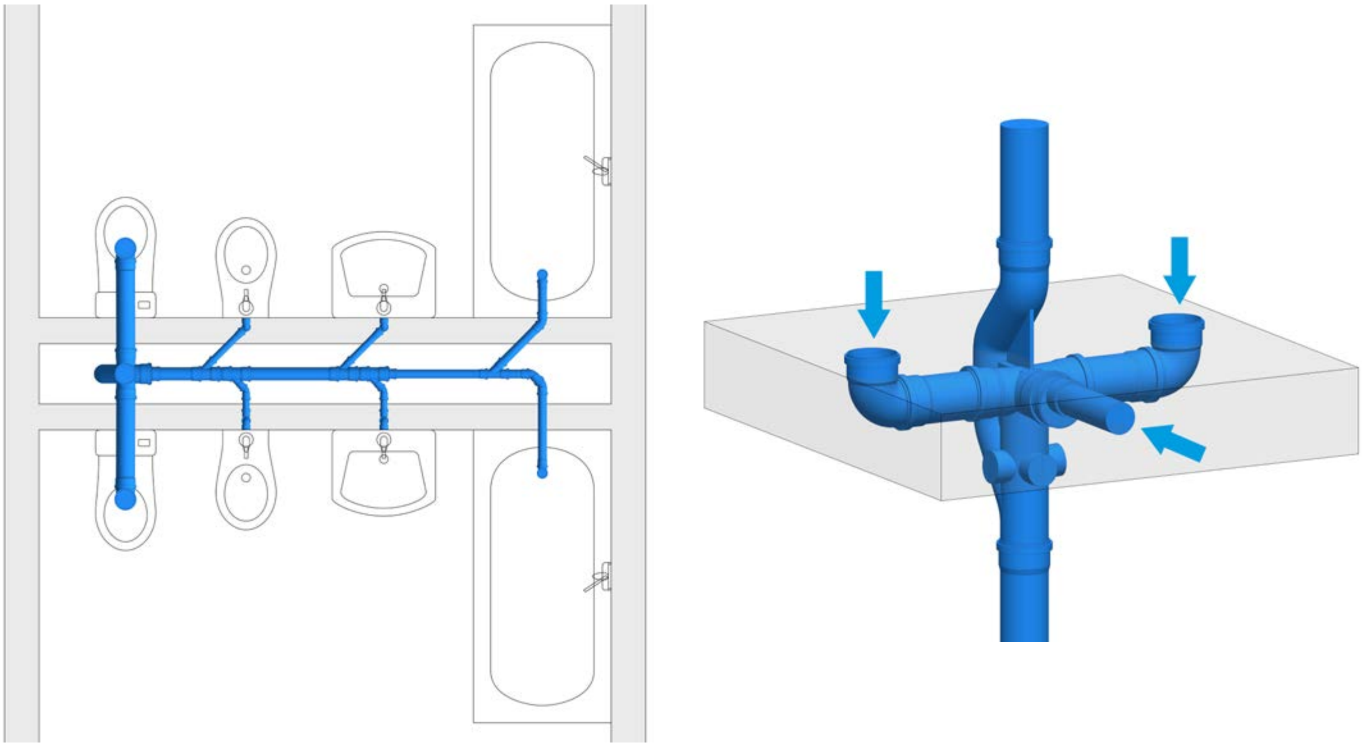
$$Q_{ww} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{147.5} = 6.07 \text{ l/s} \quad [5.2]$$

The flow rate is therefore lower than the maximum load, in that 6.07 l/s < 13.0 l/s. This means that the system can be constructed with ventilations fittings of DN 100.

Example 2. Waste system with ventilation branch fitting and segmentation of stacks
A 50 storeys building used as hotel (frequent use K=0.7) is made by several waste stacks, one of them must serve two bathrooms per floor as represented in the Figure 5.29; the technical shaft allows the ventilation branch fittings installation DN 100. Verify if it is possible to create the waste stack knowing that each floor provides:

- 2 WCs with 9 litres cistern
- 2 bidets
- 2 bathtubs
- 2 washbasins

Figure 5.29 Bathroom plan.



Flow calculation

Table 4.4 is used to calculate the total flow rate from each sanitary fixture that is connected to the ventilation branch fitting.

Table 5.11 Flows conveyed to ventilation branch fitting.

Sanitary fixture	Quantity	DU [l/s]	∑ DU [l/s]	Branch connection	Flow conveyed into connections [l/s]
WC with 9 litres cistern	1	2.5	2.5	DN 100	2.5
WC with 9 litres cistern	1	2.5	2.5	DN 100	2.5
Bathtub	2	0.8	1.6		
Bidet	2	0.5	1.0	DN 70	3.6
Washbasin	2	0.5	1.0		
Total					**8.6**

The limit of the flow entering the ventilation branch fitting (set out in chapter 5.3) is respected:

Table 5.12 Compliance with project load of ventilation branch fitting.

Limit on ventilation branch fitting	Maximum flow $\sum DU_{max}$ [l/s]	Flow calculated $\sum DU$ [l/s]	Compliance
Maximum flow in the ventilation branch fitting	25	8.6	Yes

Verification of the waste stack

The total flow from the 50 floors into the waste stack is:

$$\sum DU = 50 \cdot 8.6 = 430.0 \text{ l/s} \quad [5.3]$$

and hence the project flow, given by the equation [4.3], is:

$$Q_{WW} = K \cdot \sqrt{\sum DU} = 0.7 \cdot \sqrt{430.0} = 14.5 \text{ l/s} \quad [5.4]$$

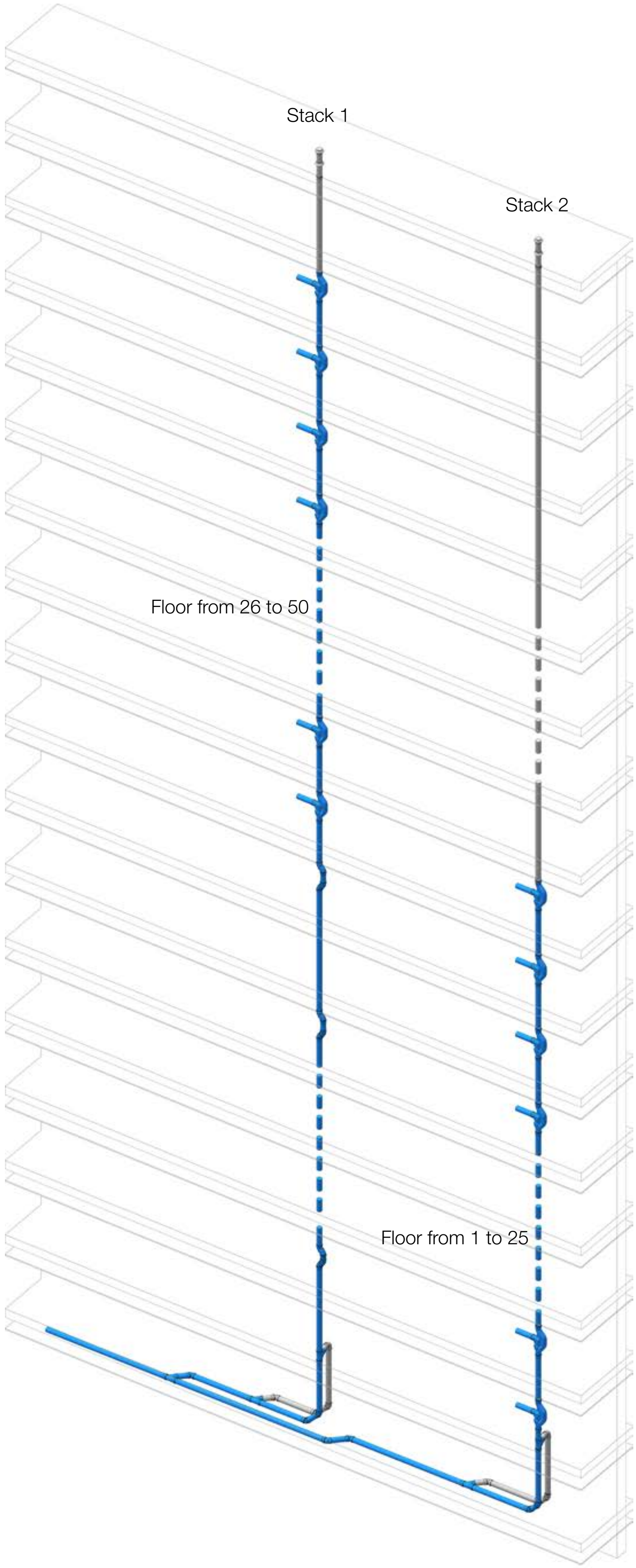
The flow rate exceeds the maximum load of a waste stack with a ventilation branch fitting of DN 100, in fact 14.5 l/s > 13.0 l/s. In this case, segmentation is required; the total load has to be distributed to different stacks. By reducing the number of floors connected to each stack to a number of 25 floors, the feasibility of this system can be verified:

$$\sum DU = 25 \cdot 8.6 = 215.0 \text{ l/s} \quad [5.5]$$

$$Q_{WW} = K \cdot \sqrt{\sum DU} = 0.7 \cdot \sqrt{215.0} = 10.3 < 13.0 \text{ l/s} \quad [5.6]$$

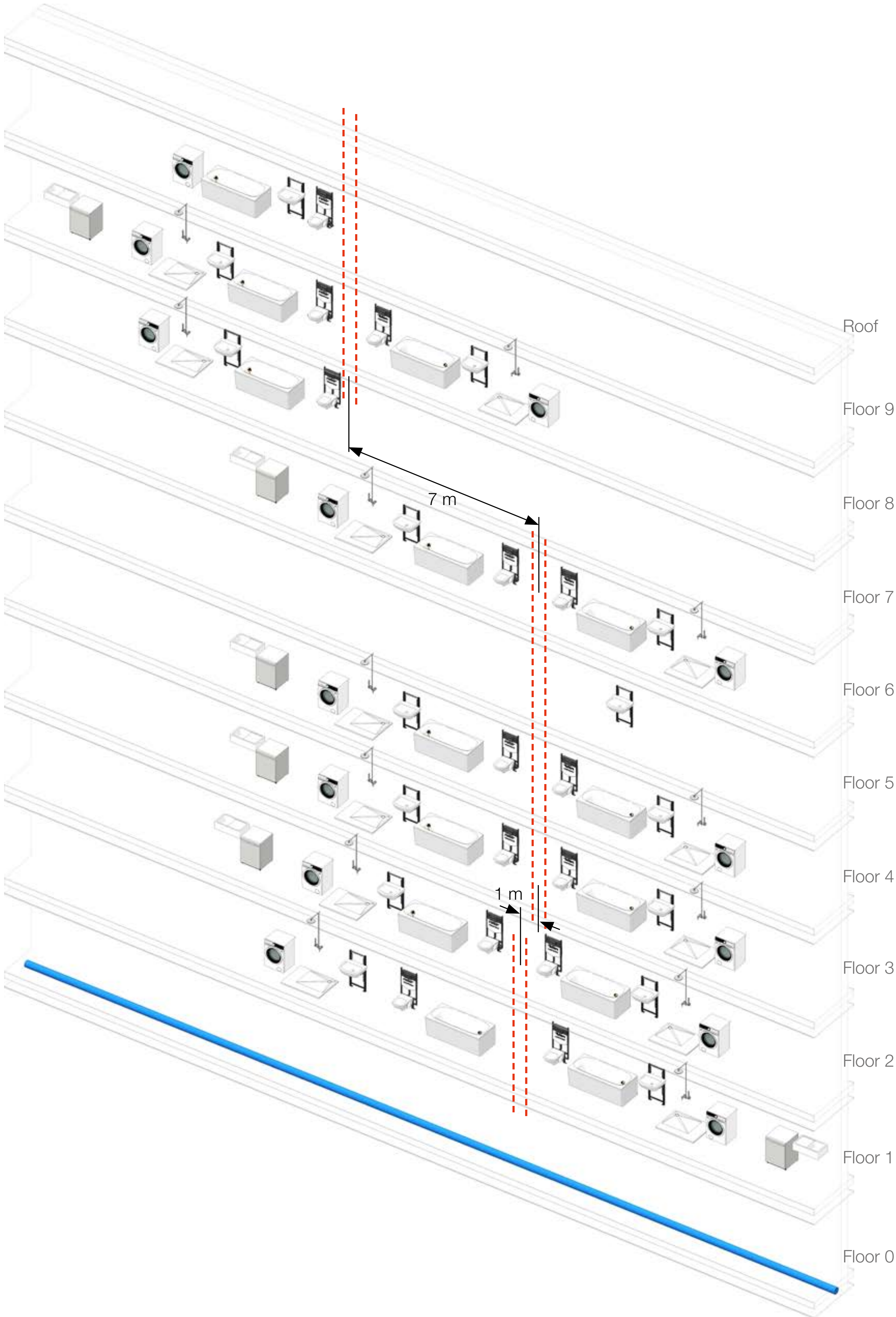
In the following figure is represented the splitting of the 50 floors in two stacks, each receiving the wastes of 25 floors.

Figure 5.30 Segmentation of stack.



Example 3. Waste system with ventilation branch fitting with stack displacement
A waste system with ventilation branch fittings is to be installed for a 10 storeys building (including a basement floor) as shown in the illustration. The illustration shows the technical shaft and the collector pipe installed on the floor of the basement. Illustrate the geometry of the circuit and complete sizing.

Figure 5.31 Building structure and arrangement of technical shaft.



Configuration of floor connections

- Floor 1 is at the base of the stack, so part of the sanitary fixtures are connected to the vertical part of the pressure relief loop using a right-angle branch and part to the horizontal segment of the pressure relief loop after at least 1 m downstream.
- The sanitary fixtures on the second floor are connected using the ventilation branch fittings using 2 DN 100 connections and 1 DN 70 connection.
- 1 m stack offsets between the second and the third floor is done using two 45° bends without any particular precautions.
- The sanitary fixtures on floors 3 and 4 are connected in a similar manner as floor 2.
- Floor 5 consists of just one sink that does not require a ventilation branch fitting, just one normal right-angle branch. The absence of a ventilation branch fitting requires the creation of an offset composed of 2+2 45° bends and a short pipe in the middle as long as 3 times the diameter to which the washbasin is connected by a DN 40 branch pipe.
- Floor 6 has the same configuration as floor 4.
- There is a stack offset of 7 m between floor 6 and 7. Since the waste flow from upper floors to this offset is lower than 5.2 l/s and the distance between the highest and the lowest discharge point for the sanitary fixtures upstream is lower than 12 m, the creation of the pressure relief loop is not needed. The sanitary fixtures at floor 7 are connected by a simple branch to the offset at more than 1 m to the beginning of the change in direction.
- Configuration of floor 8 is the same as floor 6.
- A ventilation branch fitting is used on floor 9 using the DN 100 connection for the water closet and DN 70 connection for the other sanitary fixtures.
- The stack proceeds out onto the roof covering with a vent.

Calculation of flow rates and connection diameters

Table 4.4 can be used to calculate the discharge flow from each sanitary fixture to the connections of the ventilation branch fitting for each floor. By comparing the maximum load of the DN 100 (OD 110) ventilation branch fittings, the feasibility of product application is verified. Stack segmentation or increases in diameter are not required.

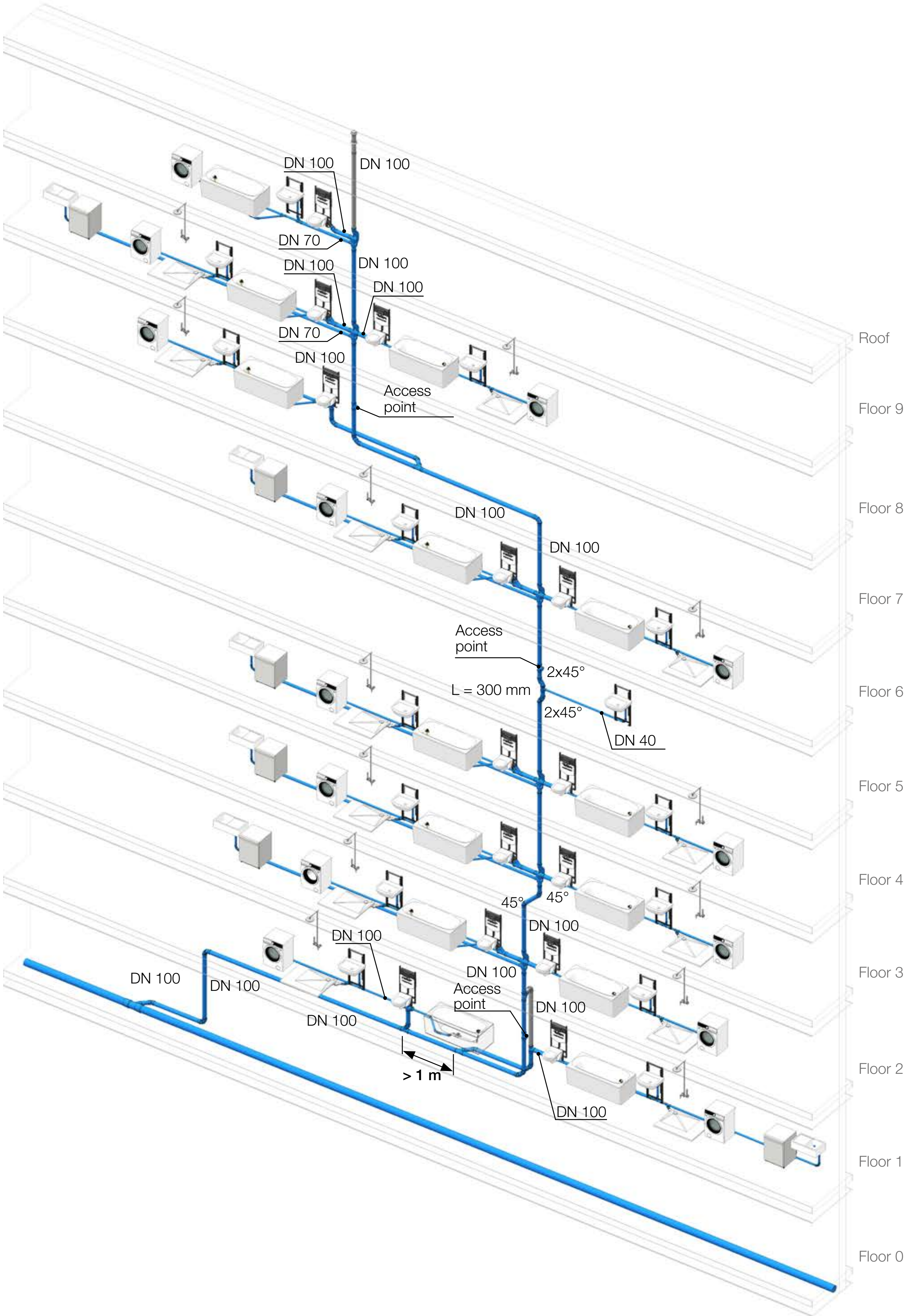
Calculation of the diameters of the floor branches is done in compliance with the chapter on the planning of waste systems according to European Standard EN 12056-2.

Table 5.13 Flows discharge into stack on each floor and breakdown of sanitary fixtures.

Floor	Sanitary fixture	Quantity	DU [l/s]	Connection to branch	∑DU Total flow [l/s]
Floor 1	WC with 6 litres cistern	1	2	DN 100 (45° branch)	4.9
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	WC with 6 litres cistern	1	2	DN 100 (right-angle branch)	6.5
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	Dishwasher	1	0.8		
	Sink	1	0.8		
Floor 2	WC with 6 litres cistern	1	2	DN 100	11.4 < 25
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	WC with 6 litres cistern	1	2	DN 100	
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	Dishwasher	1	0.8	DN 70	
	Sink	1	0.8		
Floor 3	WC with 6 litres cistern	1	2	DN 100	11.4 < 25
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	WC with 6 litres cistern	1	2	DN 100	
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	Dishwasher	1	0.8	DN 70	
	Sink	1	0.5		

Floor	Sanitary fixture	Quantity	DU [l/s]	Connection to branch	∑DU Total flow [l/s]
Floor 4	WC with 6 litres cistern	1	2	DN 100	11.4 < 25
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	WC with 6 litres cistern	1	2	DN 100	
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	Dishwasher	1	0.8	DN 70	
	Sink	1	0.5		
Floor 5	Washbasin	1	0.5	DN 40	0.5
Floor 6	WC with 6 litres cistern	1	2	DN 100	11.4 < 25
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	WC with 6 litres cistern	1	2	DN 100	
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	Dishwasher	1	0.8	DN 70	
	Sink	1	0.8		
Floor 7	WC with 6 litres cistern	1	2	DN 100 (right-angle branch)	4.9
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
Floor 8	WC with 6 litres cistern	1	2	DN 100	11.4 < 25
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	WC with 6 litres cistern	1	2	DN 100	
	Bathtub	1	0.8		
	Washbasin	1	0.5		
	Shower	1	0.8		
	Washing machine 6 kg	1	0.8		
	Dishwasher	1	0.8	DN 70	
	Sink	1	0.8		
Floor 9	WC with 6 litres cistern	1	2	DN 100	4.1 < 25
	Bathtub	1	0.8	DN 70	
	Washing machine 6 kg	1	0.8		
	Washbasin	1	0.5		

Figure 5.32 Final configuration of the waste stack.



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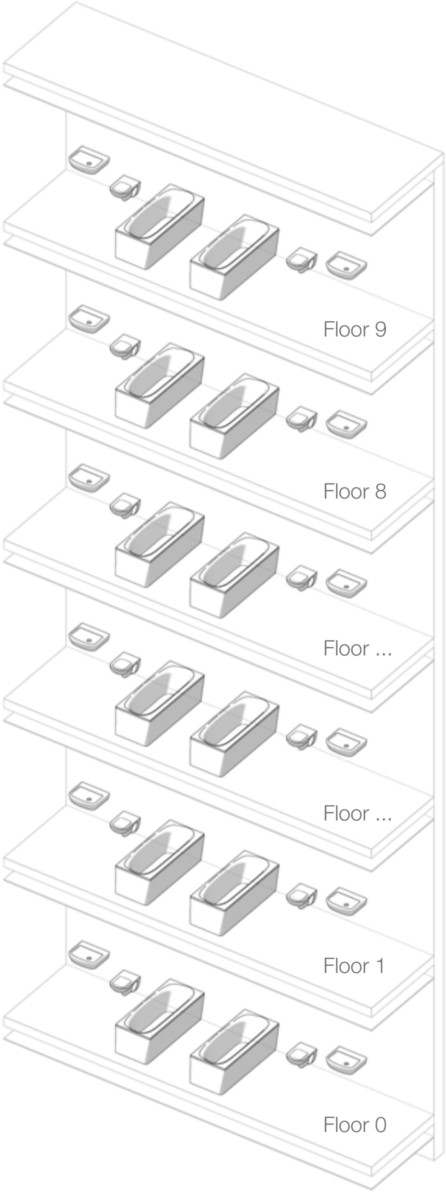
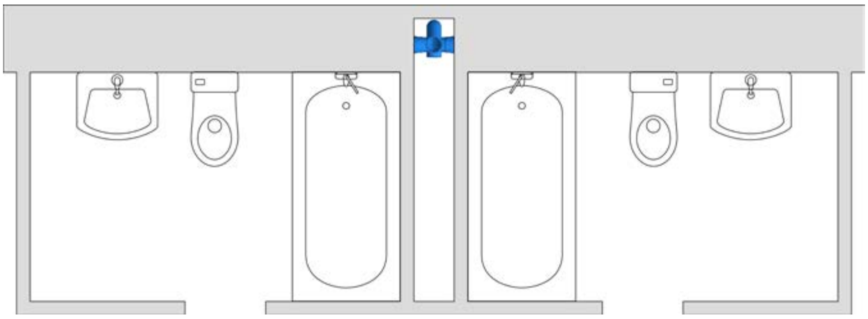
Example 4. Waste system with ventilation branch fitting and configuration of stack base
A waste system with ventilation branch fittings is to be constructed for a 9 storeys building as shown in the illustration. The ventilation branch fittings are housed in the technical shaft where the pressure relief loop must also be created. Illustrate the geometry of the circuit.

Figure 5.33 Building structure.

Layout of floors



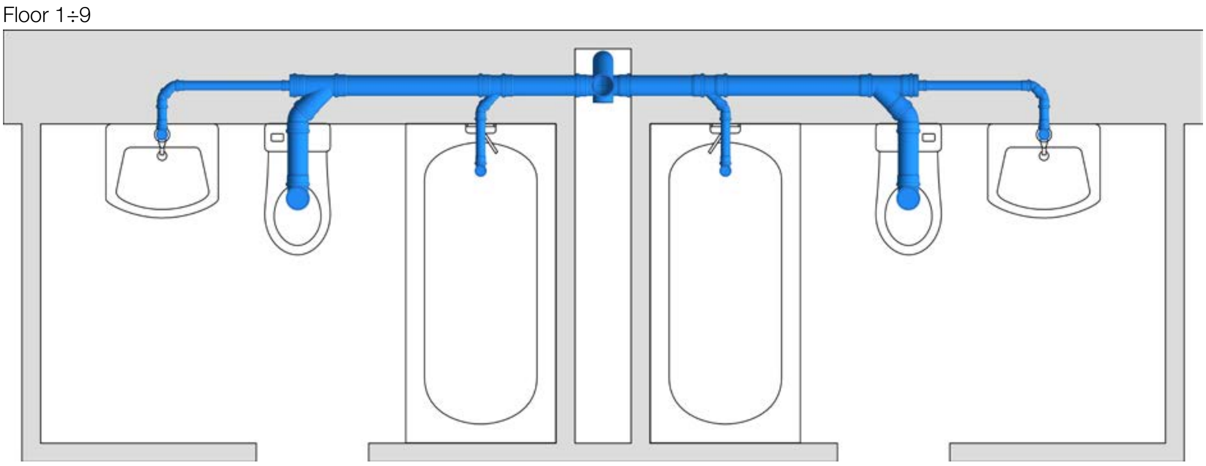
Layout of bathrooms



Definition of floor waste collectors

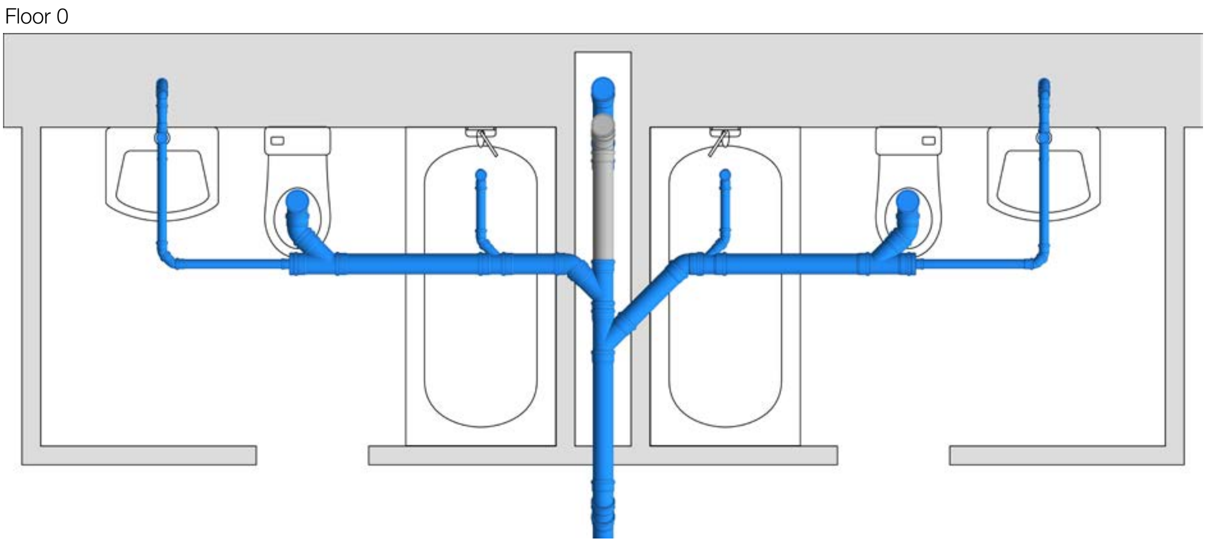
In relation to the position of the sanitary fixtures the ventilation branch fitting connections are chosen.
For floors from 1 through to 9 the lateral DN 100 connections are used.

Figure 5.34 Layout of branch pipes for floors 1 to 9.



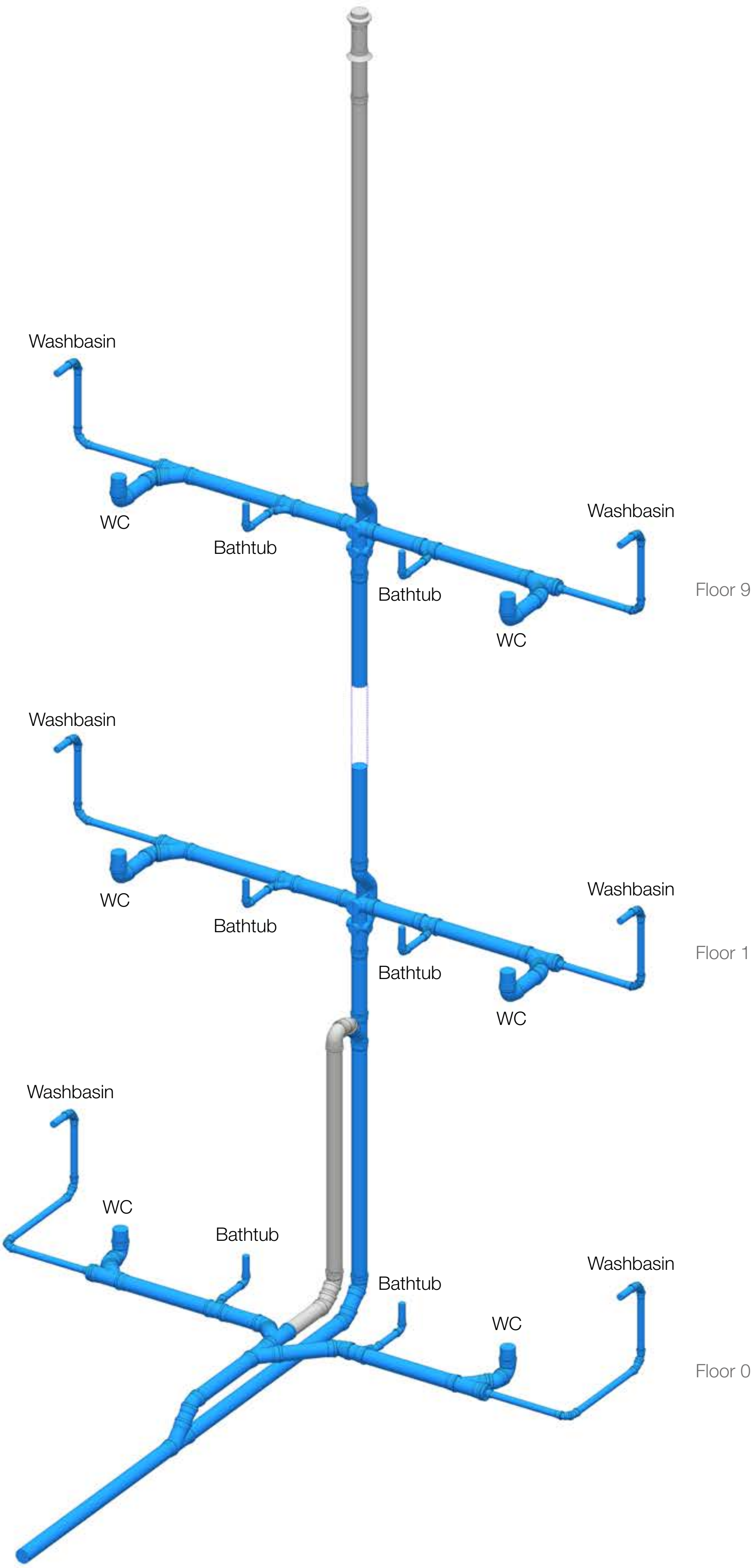
A pressure relief loop must be created on the ground floor and connection to the floors is made with simple branches to the horizontal segment.

Figure 5.35 Layout of the branch pipes for ground floor.



The final geometrical configuration of the waste system is illustrated in the following figure.

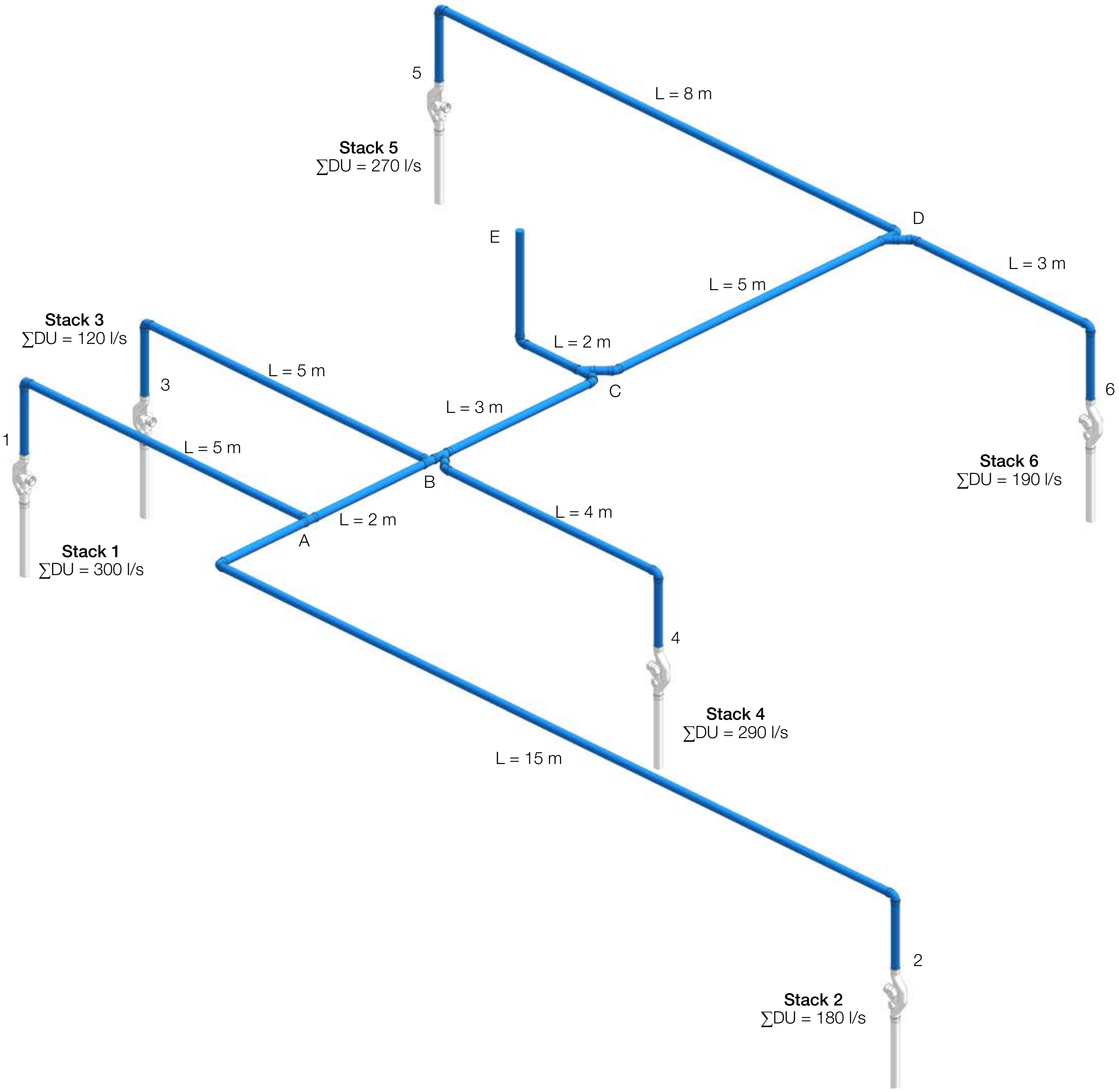
Figure 5.36 Layout of the waste system.



Example 5. Ventilation collector

Calculate the ventilation collector of the waste system with ventilation branch fittings as indicated in Figure 5.37. The values of the ∑DU of each stack are indicated in the figure as well as the diameters of the stacks.

Figure 5.37 Scheme of the ventilation collector.



The first calculation phase consists of assessing the drainage units for each segment of the ventilation collector. Even though the waste collector will hold air only, it is necessary to evaluate the hydraulic load for each single segment through its connection to the stacks.

Table 5.14 Calculation of the ∑DU for every single ventilation segment.

Segment	Segments connected	Total flow ∑DU [l/s]
1A	Stack 1	300
2A	Stack 2	180
AB	1A+2A	300+180=480
3B	Stack 3	120
4B	Stack 4	290
BC	AB+3B+4B	480+120+290=890
5D	Stack 5	270
6D	Stack 6	190
DC	5D+6D	270+190=460
CE	DC+BC	460+890=1350

The second step is about the sizing of each segment, based on the ∑DU according to the Table 5.6; the results are listed below.

Table 5.15 Calculation of the collector ventilation diameter based on the ∑DU.

Segment	Total flow ∑DU [l/s]	Diameter DN
1A	300	125
2A	180	100
AB	300+180=480	150
3B	120	100
4B	290	125
BC	480+120+290=890	200
5D	270	125
6D	190	100
DC	270+190=460	150
CE	470+890=1360	200

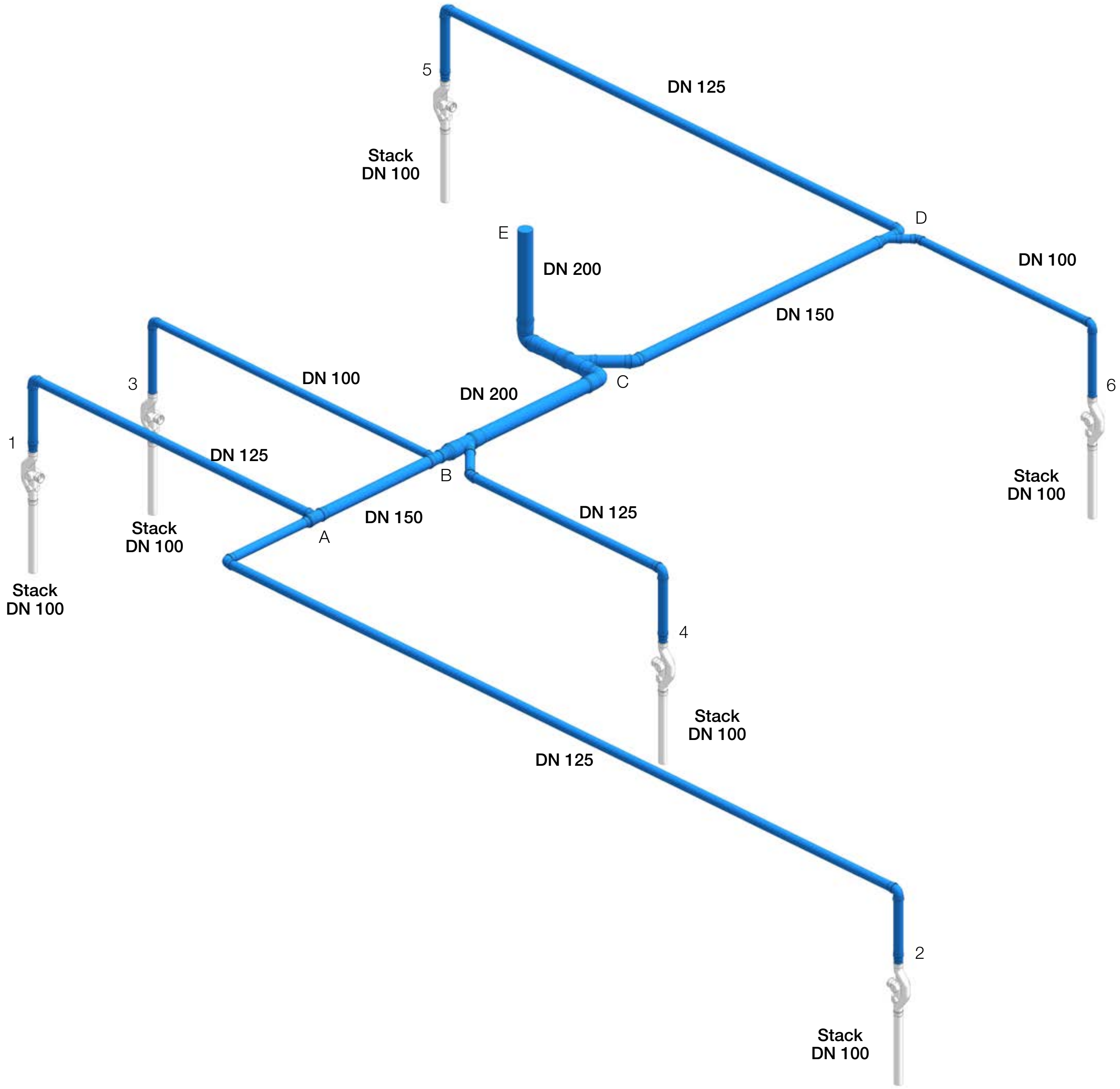
In the last step, check the ventilation segment lengths according to Table 5.7 in order to evaluate if is the case to increase the pipe size; you can see the results below.

Table 5.16 Calculation of the ventilation collector diameter based on the length of each segment.

Segment	Length [m]	Check	Diameter DN
1A	5	5 < 13 m	125
2A	15	15 > 11 m	125
AB	2	2 < 16 m	150
3B	5	5 < 11 m	100
4B	4	4 < 13 m	125
BC	3	3 < 20 m	200
5D	8	8 < 13 m	125
6D	3	3 < 11 m	100
DC	5	5 < 16 m	150
CE	2	2 < 20 m	200

The final configuration of the ventilation collector is as shown in the following figure.

Figure 5.38 Ventilation collector.



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