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Designing drainage without compromising BS EN 12056

25/01/22
CIBSE East Midlands

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RIBA CPD ASSESSED MATERIAL

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Agenda

- Introduction to Geberit
- Why design with drainage in mind?
- The history of UK drainage
- Soil and waste system types
- Limitations of primary vented stacks
- Low litre flushing and it’s affect on UK drainage
- Summary Questions

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Introduction to Geberit

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We invest in ten technology areas

Material Science

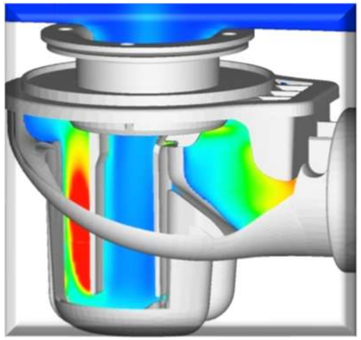
Drinking water hygiene

Statics

Hydraulics

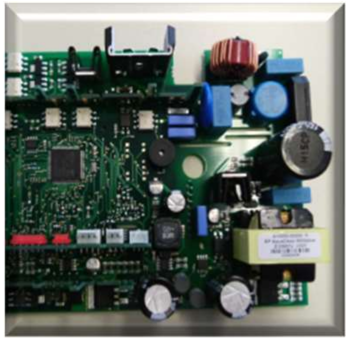
Fire protection

Process engineering



Simulations

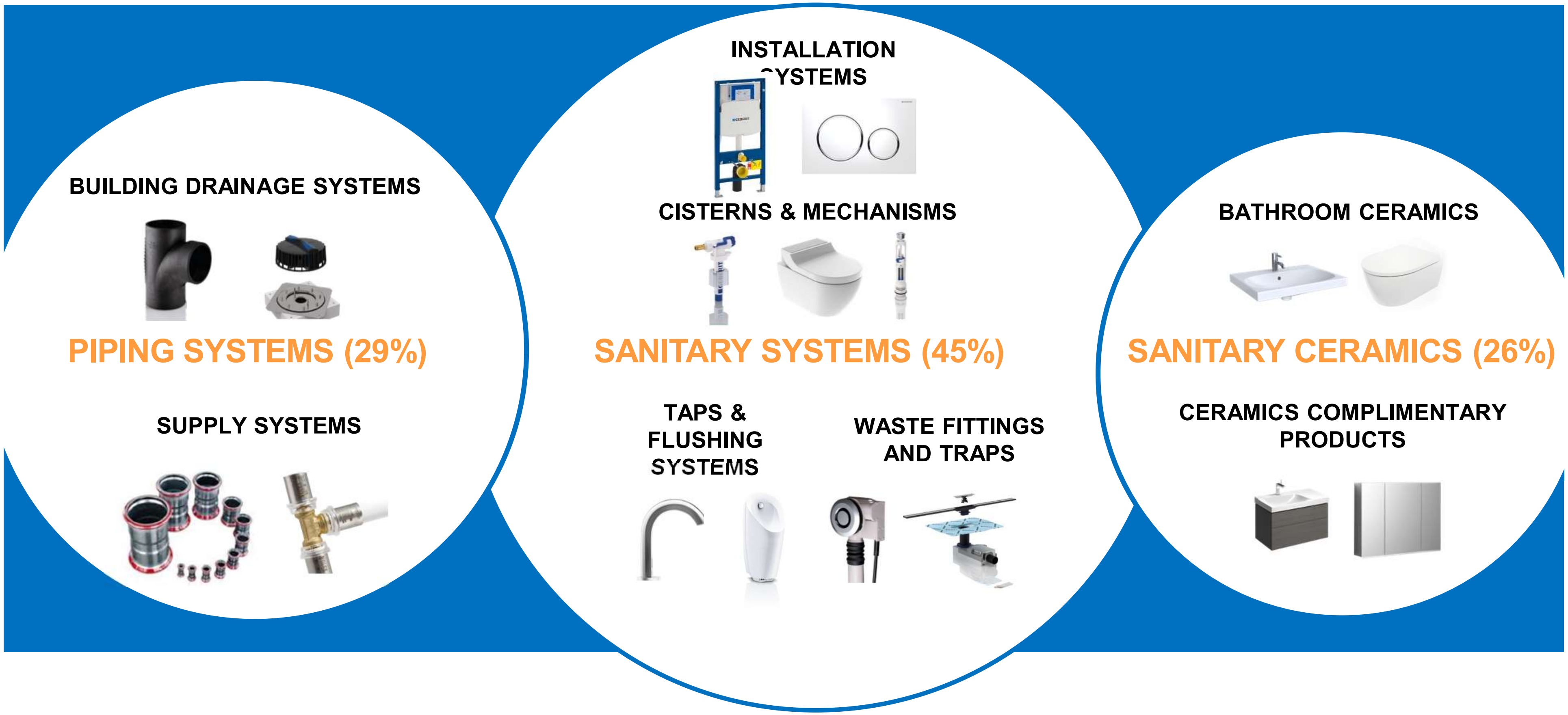
Acoustics



Electronics

Surface technology

INTRODUCTION TO GEBERIT
THREE PRODUCT AREAS



The company: 30 specialised production facilities – close to our key markets

7TH NOVEMBER 2018

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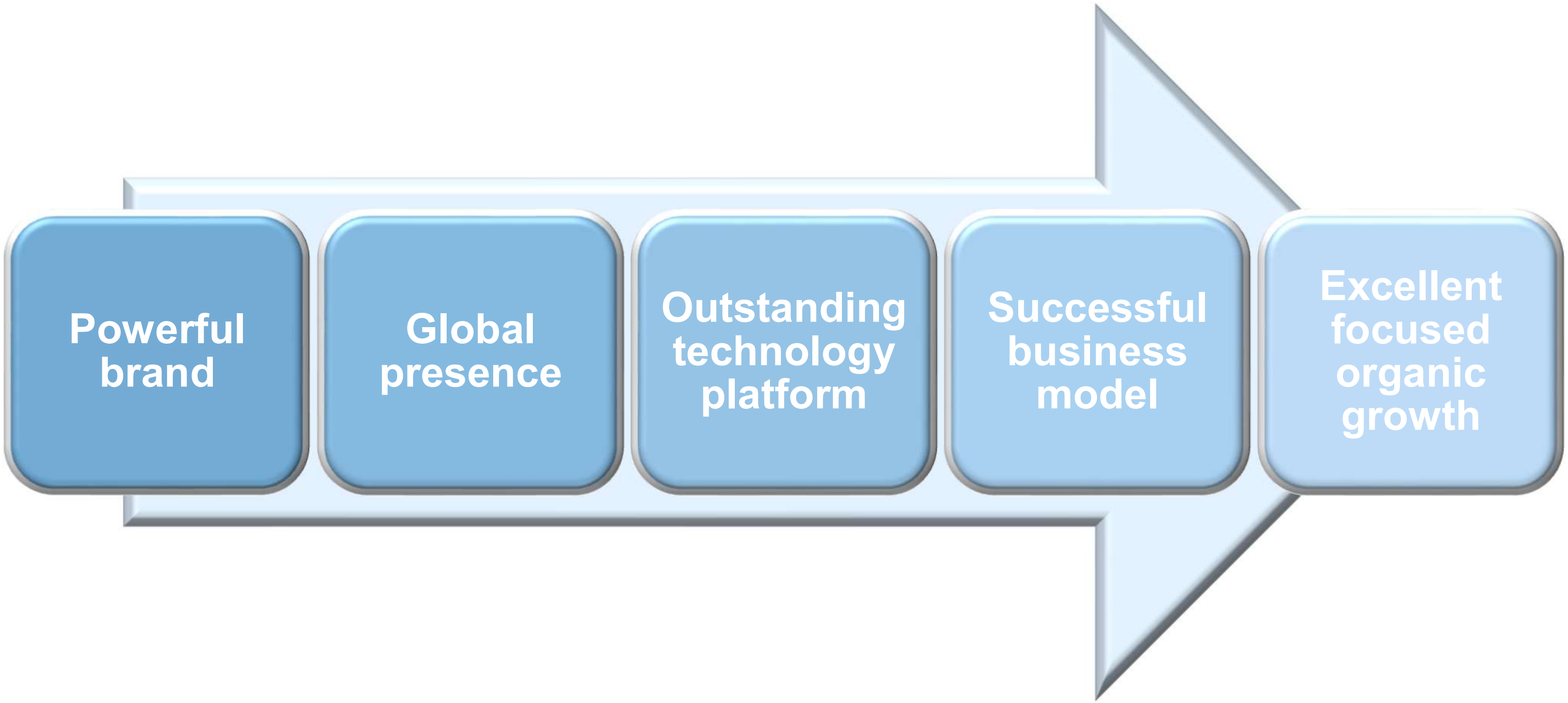
Core statements

The European market leader in sanitary technology



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Why design with drainage in mind?

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Fresh water comes from the pipe…

…Dirty water disappears down the drain

SIMPLY THE WAY IT WORKS

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Why think about drainage design?

Nobody thinks about drainage design…

…until it becomes a problem

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The history of UK drainage

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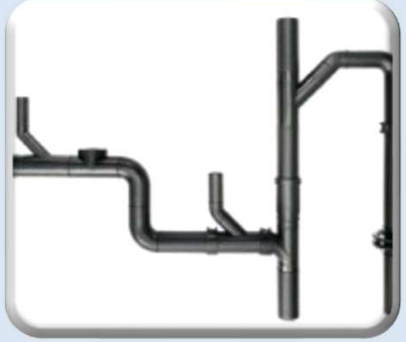
What is traditionally used in the UK for drainage?

Cast Iron has been used for drainage since the 17th century

uPVC drainage was introduced from the 1960s, followed by similar systems such as ABS and PP



HDPE was introduced by Geberit in the UK in the 1980s

Acoustically optimised drainage pipe system launched by Geberit in 1997

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Jointing techniques

Butt weld

Electro welded sleeve coupling

Ring seal socket

Expansion socket

Screw-threaded joint

Flange

✓ Easy to cut and handle

✓ Easy, strong and reliable joints

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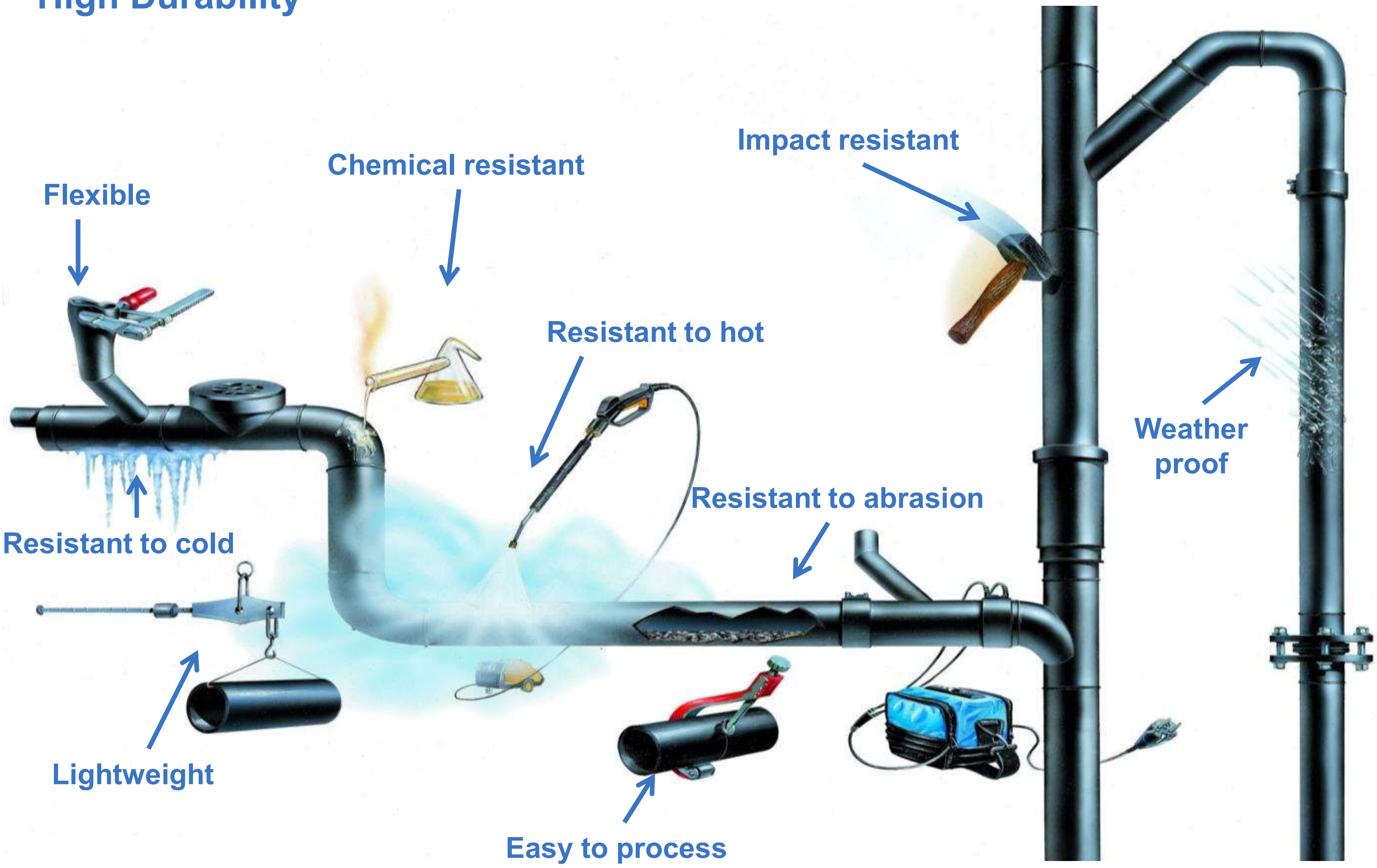
High Durability



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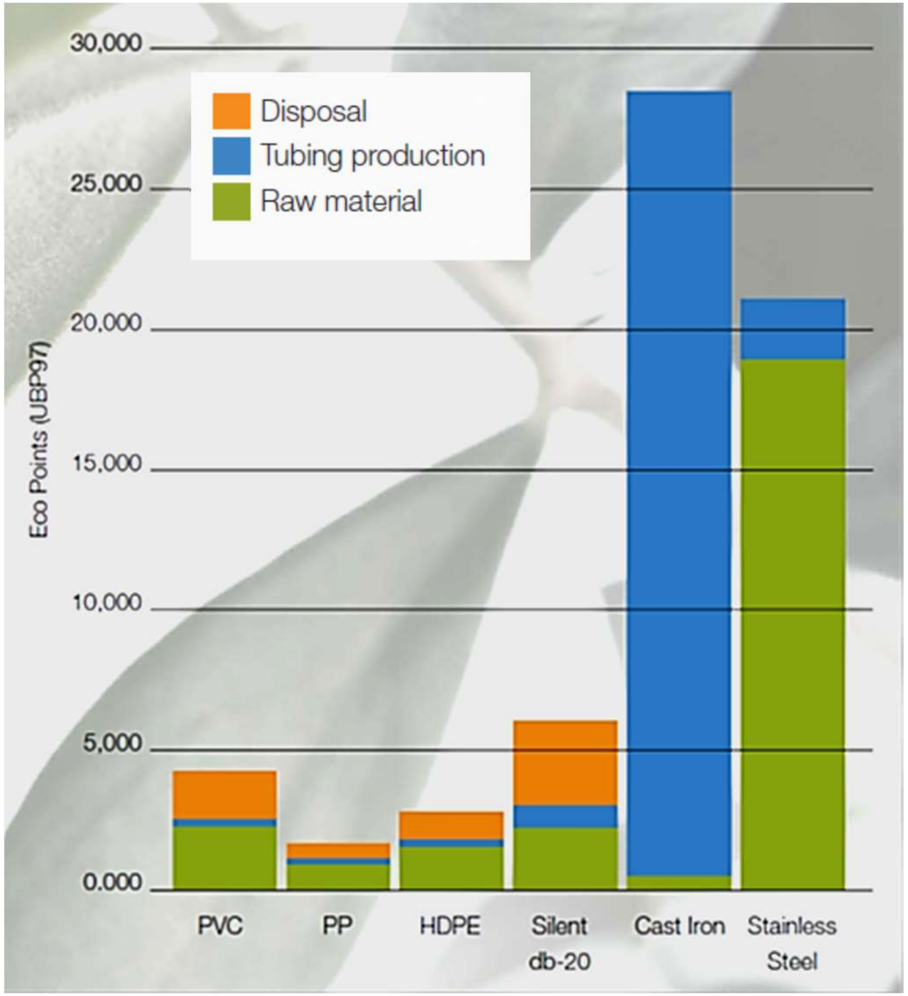
Environmental Benefits



- No air pollution in production of pipes
- Reduced transport cost due to weight
- No chemicals used in jointing
- Reduced scrap
- Easily recyclable

HDPE is recommended by Greenpeace as an alternative to traditional drainage materials.

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Soil and waste system types

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BS EN 12056 – Gravity Drainage Systems inside buildings

- Part 1: General and performance requirements
- Part 2: Sanitary pipework, layout and calculation
- Part 3: Roof drainage, layout and calculation (BS 6367)
- Part 4: Wastewater lifting plants- Layout and calculation
- Part 5: Installation and testing,instructions for operation, maintenance and use

Soil and Waste System Types

System I (German / Swiss / Austrian Practice)

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

System II (Scandinavian Practice)

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

System III (UK Practice)

- Single stack system with full bore branch discharge pipes.
- Sanitary appliances are connected to full bore 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 (French Practice)

- Drainage systems type I, II & III may also be divided into black water stack serving WC's and urinals and a grey water stack serving other appliances.

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Five Main Design Criteria - SAGAA

Size	• Pipes will be large enough to carry anticipated discharge
Airtight & Watertight	• Foul air must be excluded from entering the building. • Leakage must be prevented
Gradient	• A fall is to be provided on all pipes
Access	• To be provided for testing and maintenance
Acoustics	• Where sound insulation is required

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Sizing - Branches

Sizing of branch and low gradient collector pipework:	
40mm	wash basin, bidet, drinking fountain.
50mm	sink, bath, shower, urinal, sanitary towel macerator.
56mm	combined wastes, disposal unit or dual appliance branch.
110mm	WC (90mm with 80mm outlet pan).

Houses never need sizing as a single WC requires a 110mm stack but this would also suffice for 50 houses each with one WC.

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Sizing - Stacks

1 Using table 2, select the total number of appliances running into the stack

2 Add up the discharge units, DU, for these appliances

BS EN 12056-2 Table 2 - Discharge Units (DU)

Appliance	System I	System II	System III	System IV
	DU l/s	DU l/s	DU l/s	DU l/s
Wash basin, bidet	0.5	0.3	0.3	0.3
Shower without plug	0.6	0.4	0.4	0.4
Shower with plug	0.8	0.5	1.3	0.5
Single urinal with cistern	0.8	0.5	0.4	0.5
Urinal with flushing valve	0.5	0.3	-	0.3
Slab urinal	0.2*	0.2*	0.2*	0.2*
Bath	0.8	0.6	1.3	0.5
Kitchen sink	0.8	0.6	1.3	0.5
Dishwasher (household)	0.8	0.6	0.2	0.5
Washing machine up to 6kg	0.8	0.6	0.6	0.5
Washing machine up to 12kg	1.5	1.2	1.2	1.0
WC with 4.0 l cistern	**	1.8	**	**
WC with 6.0 l cistern	2.0	1.8	1.2 to 1.7***	2.0
WC with 7.5 l cistern	2.0	1.8	1.4 to 1.8***	2.0
WC with 9.0 l cistern	2.5	2.0	1.6 to 2.0***	2.5
Floor gully DN 50	0.8	0.9	-	0.6
Floor gully DN 70	1.5	0.9	-	1.0
Floor gully DN 100	2.0	1.2	-	1.3

* Per person
** Not permitted
*** Depending upon type (valid for WCs with syphon flush cistern only)
\- Not used or no data

Sizing - Stacks

3 Select the frequency factor for the use of the appliances using table 3

4 Work out the waste water flow rate Q_{ww}

BS EN 12056-2 Table 3 - Typical frequency factors (K)

Usage of appliances	*K*
Intermittent use, e.g. in dwelling, guesthouse, office	0.5
Frequent use, e.g. in hospital, school, restaurant, hotel	0.7
Congested use, e.g. in toilets and/or showers open to public	1
Special use, e.g. laboratory	1.2

Waste Water flowrate (Q_{ww}) is the expected flowrate of waste water in a part or in the whole drainage system where only domestic sanitary appliances are connected to the system

here: $$Q_{ww} = K\sqrt{\sum DU}$$

Q_{ww} = Waste water flowrate
K = Frequency factor
$\sum$**DU** = Sum of discharge units

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Sizing - Stacks

5

Use the Q_{ww} (litres per second) to size the pipe using table 11.

Hydraulic capacity can be increased with the use of secondary venting - use table 12 in place of 11

Swept entry fittings are used in the UK but there is also a column for sizing square entries.

BS EN 12056-2 Table 11 - Hydraulic capacity (Q_{max}) and nominal diameter

Stack and stack vent	System I, II, III, IV Q_{max} (l/s)	
DN	Square entries	Swept entries
60	0.5	0.7
70	1.5	2.0
80*	2.0	2.6
90	2.7	3.5
100**	4.0	5.2
125	5.8	7.6
150	9.5	12.4
200	16.0	21.0

* Minimum size where WCs are connected in system II.

** Minimum size where WCs are connected in system I, III, IV.

BS EN 12056-2 Table 12 - Hydraulic capacity (Q_{max}) and nominal diameter

Stack and stack vent	Secondary vent	System I, II, III, IV Q_{max} (l/s)	
DN	DN	Square entries	Swept entries
60	50	0.7	0.9
70	50	2.0	2.6
80*	50	2.6	3.4
90	50	3.5	4.6
100**	50	5.6	7.3
125	70	7.6	10.0
150	80	12.4	18.3
200	100	21.0	27.3

* Minimum size where WCs are connected in system II.

** Minimum size where WCs are connected in system I, III, IV.

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Sizing - e.g. Football stadium (congested)

$$Q_{ww} = K\sqrt{\sum DU}$$

Fifty 6-litre WCs = 50 x 1.7 = 85

One hundred WHBs = 100 x 0.3 = 30

Total Discharge Units = 115

BS EN 12056-2 Table 2 - Discharge Units (DU)				
Appliance	**System I DU l/s**	**System II DU l/s**	**System III DU l/s**	**System IV DU l/s**
Wash basin, bidet	0.5	0.3	0.3	0.3
Shower without plug	0.6	0.4	0.4	0.4
Shower with plug	0.8	0.5	1.3	0.5
Single urinal with cistern	0.8	0.5	0.4	0.5
Urinal with flushing valve	0.5	0.3	-	0.3
Slab urinal	0.2*	0.2*	0.2*	0.2*
Bath	0.8	0.6	1.3	0.5
Kitchen sink	0.8	0.6	1.3	0.5
Dishwasher (household)	0.8	0.6	0.2	0.5
Washing machine up to 6kg	0.8	0.6	0.6	0.5
Washing machine up to 12kg	1.5	1.2	1.2	1
WC with 4.0 l cistern	**	1.8	**	**
WC with 6.0 l cistern	2	1.8	1.2 to 1.7***	2
WC with 7.5 l cistern	2	1.8	1.4 to 1.8***	2
WC with 9.0 l cistern	2.5	2	1.6 to 2.0***	2.5

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$Q_{ww} = K\sqrt{\sum DU}$

Fifty 6-litre WCs = 50 x 1.7 = 85

One hundred WHBs = 100 x 0.3 = 30

Total Discharge Units = 115

$\sqrt{115} = 10.7$

Frequency factor = 1.0

BS EN 12056-2 Table 3 - Typical frequency factors (*K*)	
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Special use, e.g. laboratory	1.2

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Fifty 6-litre WCs = 50 x 1.7 = 85

One hundred WHBs = 100 x 0.3 = 30

Total Discharge Units = 115

$\sqrt{115}$ = 10.7

Frequency factor = 1.0

Waste Water Flowrate, Q_{ww} = 10.7 x 1.0 = 10.7 l/s

Therefore a 150mm stack is required

BS EN 12056-2 Table 11 - Hydraulic capacity (Q_{max}) and nominal diameter

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Gradient	• A fall is to be provided on all pipes
Access	• To be provided for testing and maintenance
Acoustics	• Where sound insulation is required

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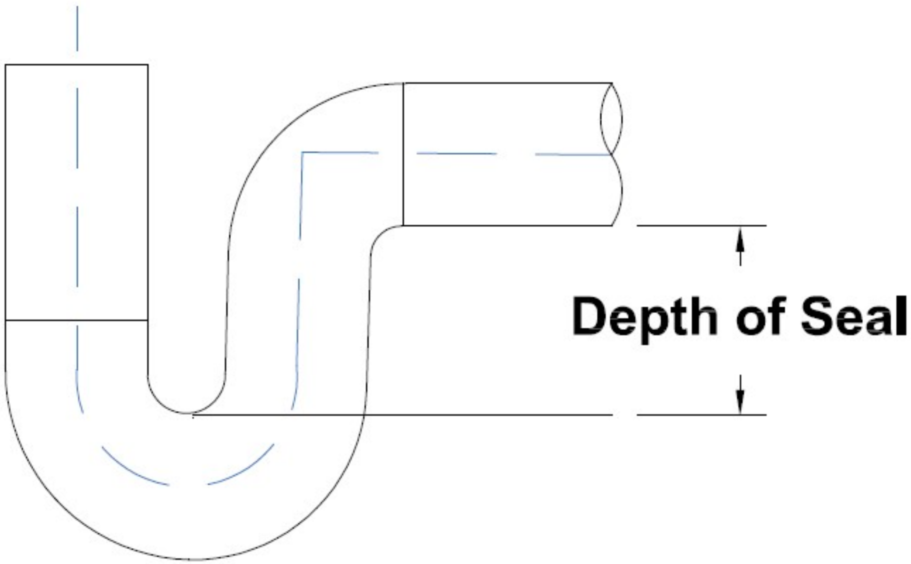
Air & Watertight – Traps

Depth of Water Seals	
Wash basin / bidet	75mm
Bath / Shower	50mm
Sink / Disposal	75mm
WC Pan	50mm

There are some traps on the market for baths and showers with a seal depth of 38mm.



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Air & Watertight – Drainage Jointing Methods

Butt fusion welding

- HDPE

Electrofusion welding

- HDPE

Ring seal joints

- All systems

We would recommend homogeneous welds for commercial, high rise and industrial applications

Solvent welding

- PVC-u

Two part clamps

- Cast iron

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Air & Watertight – HDPE Jointing Methods

Butt weld

Electro welded sleeve coupling

Ring seal socket

Expansion socket

Screw-threaded joint

Flange

- ✓ Easy to cut and handle
- ✓ Easy, strong and reliable joints

Five Main Design Criteria - SAGAA

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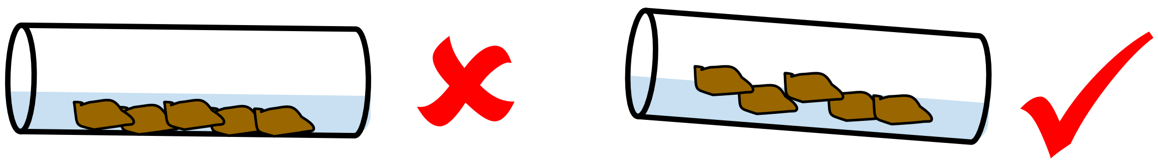
Gradient



- The gradient of a branch discharge pipe should be uniform and adequate to drain the pipe efficiently
- **Waste systems**
  - Gradient should be between 1° and 5°
  - Max distance of appliance to stack = 3m
  - Over 3m access needs to be provided
  - Normally 1.25°
- **Soil systems**
  - Gradient should be between 1° and 5°
  - Normally 2.5°

(1° = 18mm drop per metre)

(5° = 88mm drop per metre)

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Five Main Design Criteria - SAGAA

Size	• Pipes will be large enough to carry anticipated discharge
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Gradient	• A fall is to be provided on all pipes
Access	• To be provided for testing and maintenance
Acoustics	• Where sound insulation is required

Access

- Sufficient access should be provided to enable all pipework to be tested and maintained
- Access covers, caps etc should be sited to facilitate the insertion of testing equipment and the use of cleaning equipment and /or for the removal of blockages
- Use of equipment should not be impeded by the structure or other services
- Access points should not be located where they will give rise to nuisance or danger if spillage occurs
- Fit access above spill level and extend to the face of a duct or floor level

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Five Main Design Criteria - SAGAA

Size	• Pipes will be large enough to carry anticipated discharge
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What is noise?

Noise is unwanted sound…

…sound is subjective

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The annoyance of sanitary noise

90%

... don't like
waste water noise.

90%

... have been
disturbed by waste
water noise.

55%

... would pay a little
more rent to
reduce the noise.

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Acoustic Performance

- Many areas have high requirements for acoustic insulation
  - Residential premises
  - Office buildings
  - Hospitals
  - Sanatoriums
  - Hotels

- Acoustically designed HDPE can be used in these instances, providing superior sound dampening combined with the material benefits of HDPE…

… but, a holistic approach to sanitary system design is critical to achieve optimal acoustic performance!
The noise doesn't only come from the drainage pipes

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Silent-db20 – Acoustically Designed HDPE

- The system’s properties are the same as HDPE but with the added benefit of being a denser product thanks to the addition in the mix of 20% ground stone.
- The ribs on the fittings further dampen the transfer of sound at impact areas.
- Pipes, fittings and acoustic brackets available in sizes Ø56mm up to Ø160mm for soil and waste drainage

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Limitations of Primary Vented Stacks (PVS)

Limitations of Primary Vented Stacks (PVS)

The UK system III allows us to fill our branch discharge pipes 100%

There are rules governing the length and diameter of branch discharge pipes for a primary vented system

In the worst case scenario using a primary vented system, traps can be siphoned by the build up of negative pressure in the system as there is only one access point for air. Positive pressure, created at transition areas in the stack can also force foul air out through appliance traps.

Therefore a primary vented system is only recommended for domestic and light commercial/industrial installations.

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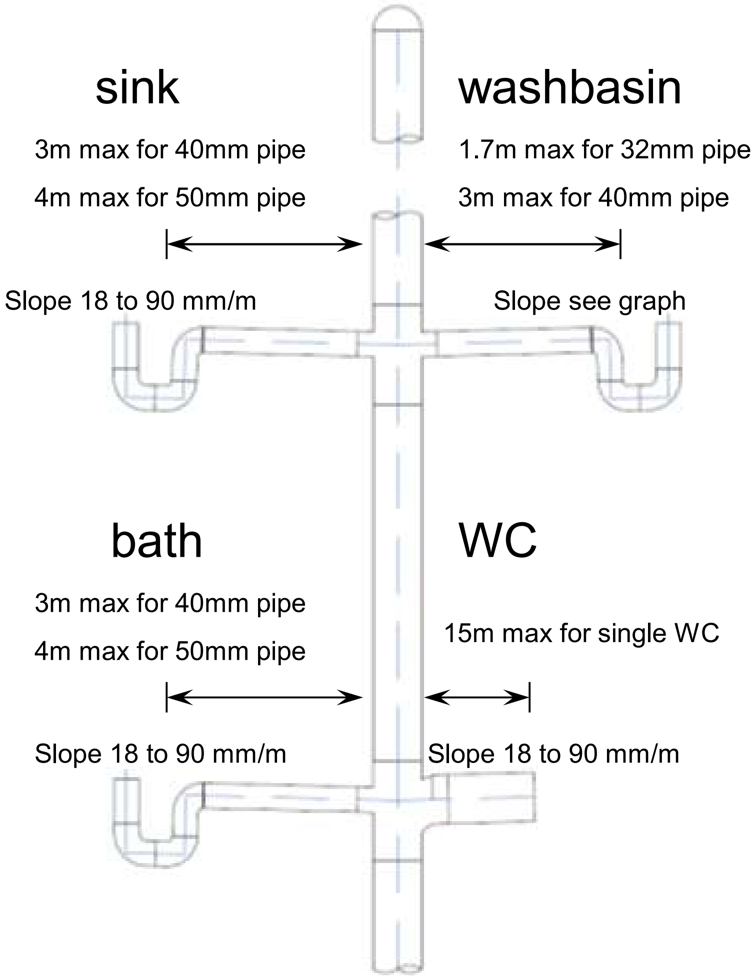
Design Guidelines for Branch Pipes (PVS)

Table 2 of the UK Building Regulation H shows clearly the diameters and lengths allowed for branch pipes in an primary vented system

Table 2 **Common Branch discharge pipes (unventilated)**

Appliance	Max no. to be connected	Max length of branch pipe (m)	Min size of pipe (mm)	Gradient limits (mm fall per metre)
WC outlet > 80mm	8	15	100	18[2] to 90
WC outlet < 80mm	1	15	75[3]	18 to 90
Urinal – bowl		3[1]	50	
Urinal – trough		3[1]	65	18 to 90
Urinal – slab		3[1]		
Washbasin or bidet	3	1.7	30	18 to 22
		1.1	30	18 to 44
		0.7	30	18 to 87
		3.0	40	18 to 44
	4	4.0	50	18 to 44

[1] Should be as short as possible to prevent deposition
[2] May be reduced to 9mm on long drain runs where space is restricted, but only if more than 1 WC is connected
[3] Not recommended where disposal of sanitary towels may take place via the wc, as there is an increased risk of blockages.
[4] Slab urinals longer than 7 persons should have more than one outlet.



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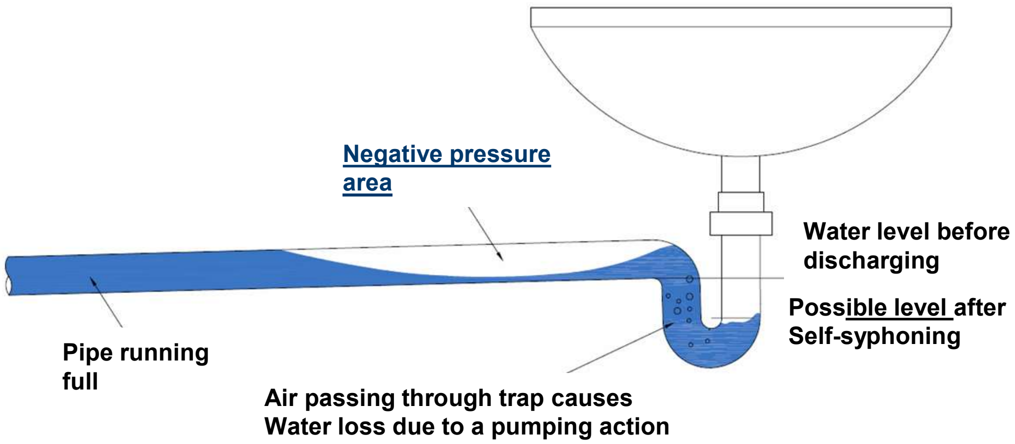
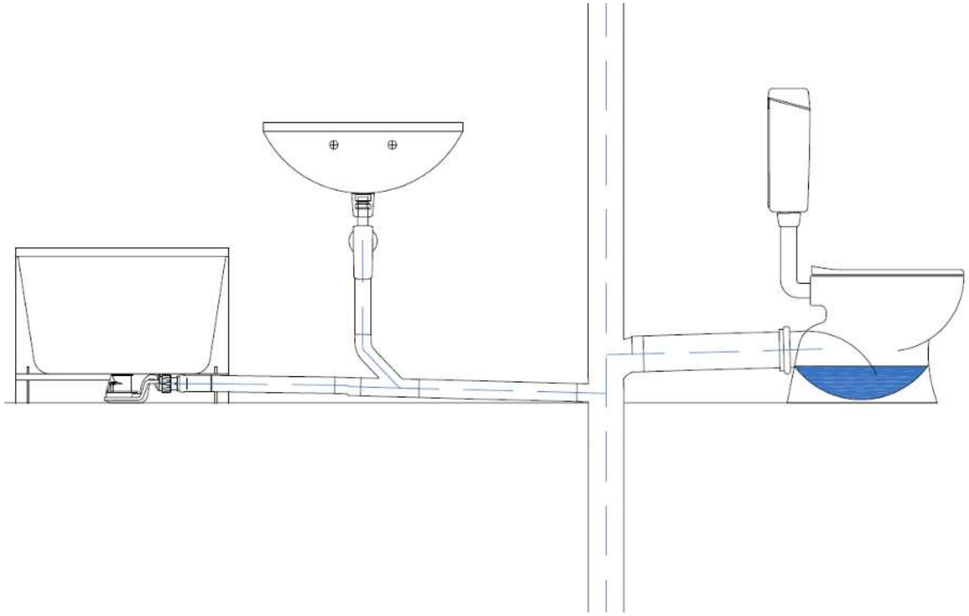
Siphoning Traps

- **Self siphonage** – Branch pipe fills up causing an area of negative pressure to be left behind in the pipe. This negative pressure acts on the trap once the basin has run empty causing the trap level to fall.



- **Induced siphonage (combined wastes)** – Caused when two appliances are connected to the same branch pipe (typically bath and basin). The branch pipe connected to the stack fills up and the water flowing from the bath past the basin sets up a venturi which causes negative pressure in the basin pipe acting on the basin trap.



Solution to Siphoning Traps

- Increase the pipe size immediately after the trap
- Ensure the pipe length between end appliance and pipe is less than 1.7m when the slope is less than 1.25 degrees
- Use resealing or Anti-vacuum traps
- Fit an air admittance valve (this has limitations)
- Fully vent the system (the preferred and best solution)
- Use a sovent fitting

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Rules for Using Air Admittance Valves (AAV)

- The head of the drain should always vent to atmosphere

- A ratio of 9:1 max should be used

- Not suitable over 5 storeys (some AAV's claim 10)

- Will only deal with negative pressure!

- Should never be used outside

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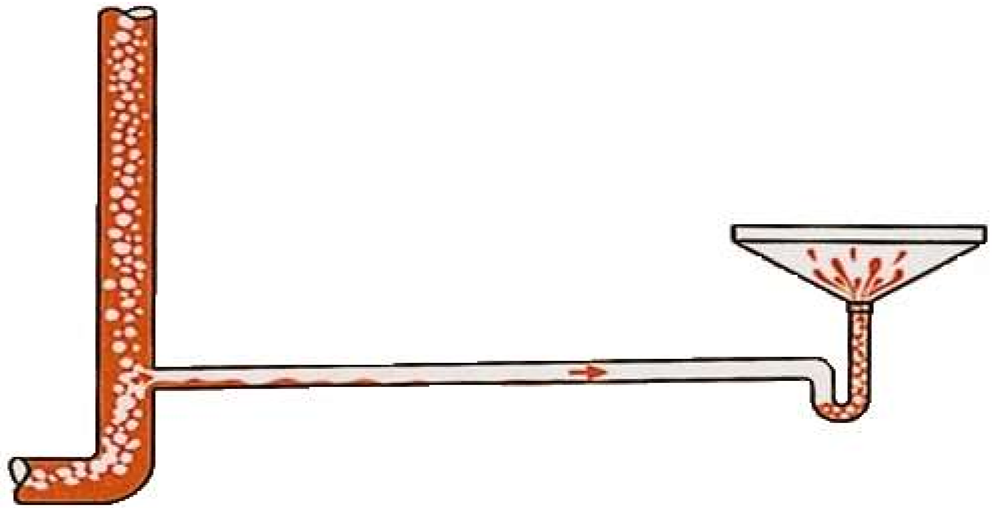
Offsets and Base of Stack Bends

- Positive pressure is created within a soil and waste system at offset areas and at base of stack bends.

- A PVS can dissipate this air surcharge in domestic and light commercial installations but heavy utilisation of this installation could cause the traps to be blown



- For base of stack bends strict rules govern the diameter of the bend and connection distances from the bend to the first appliance.

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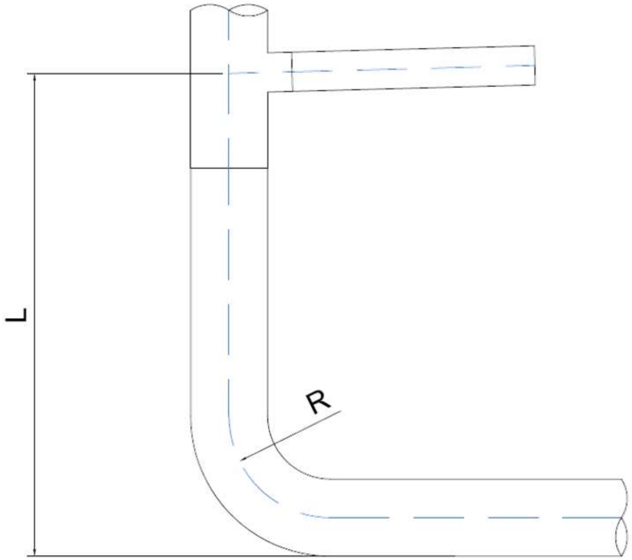
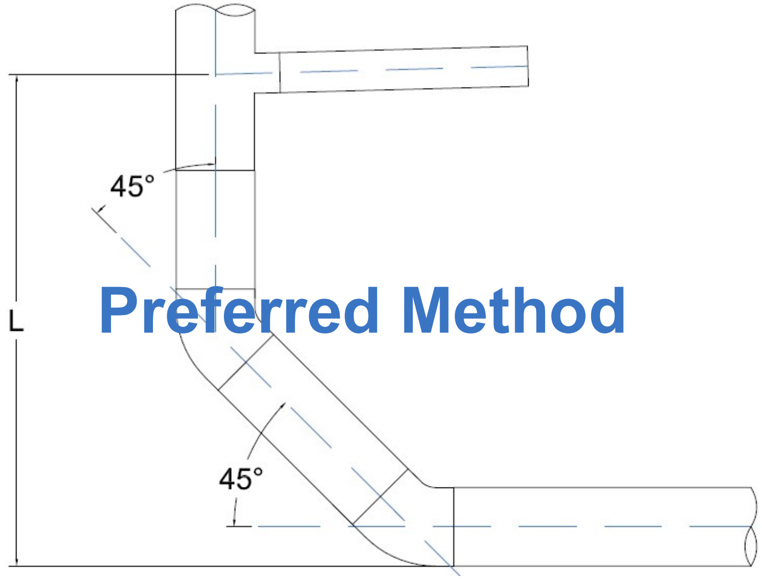
Base of Stack Bends

- Minimum connection distance L
  - Up to 3 Floors 450mm
  - Up to 5 Floors 740mm
  - Above 5 Floors 1 Floor
- Minimum radius R = 200mm
- At least Double the Pipe Diameter
- Movie to highlight positive pressure effects…





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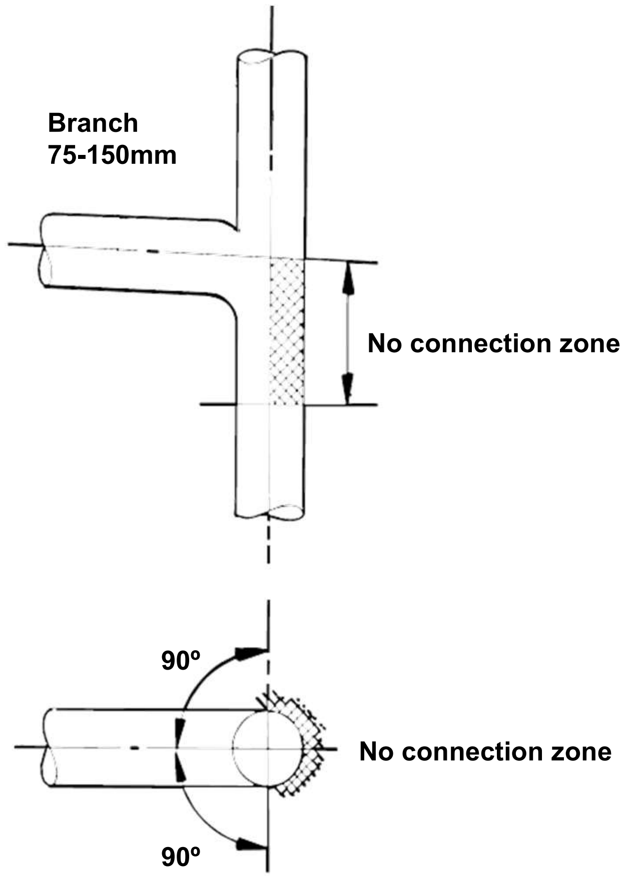
Prevention of Crossflow

• WC Waste to Waste Crossflow

- With large branches, there is a **no connection zone** on the opposing side of the stack for smaller branches.
- The branch should be connected at or above the centre line level of the large branch or at least 200mm below it.
- Alternatively the small branch should be a right angles or less to the large branch.



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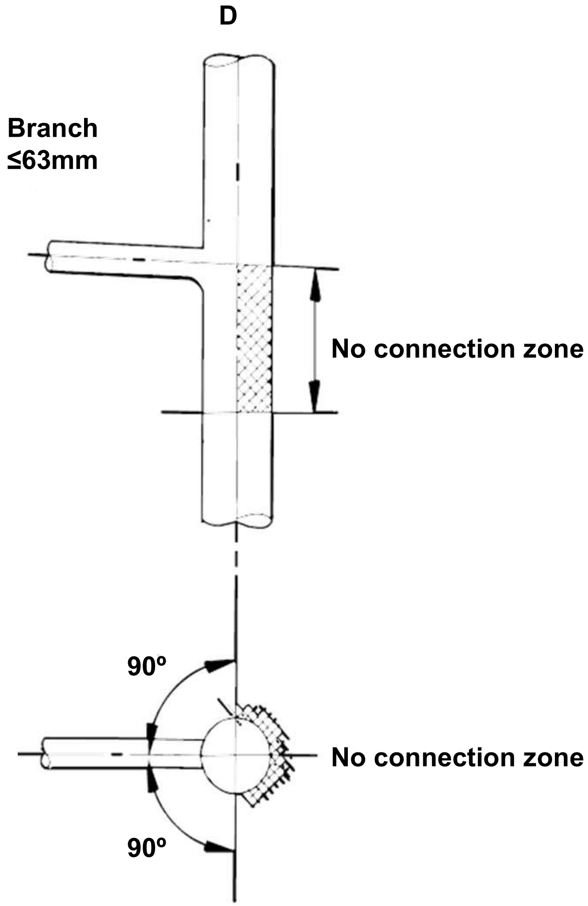
Prevention of Crossflow

- **Waste to Waste Crossflow**
  - With small branches, the **no connection zone** is dependent on the stack diameter, D.

Stack Diameter, D	No connection zone (mm)
75	90
100	110
125	210
150	250

  - Alternatively the second branch should be a right angles or less to the first.



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Designing drainage without compromise

Low volume flushing and it’s effect on UK drainage

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History of water consumption for WC's

12 l | 9 l | 6 l | 4.5 l | ? l

1905	1952	1964	1970	1996	2008	????
Wooden cistern Phoenix	First plastic cistern	Concealed plastic cistern	Stop and go	Dual flush	4.5 l flush	

Less water requires more expertise in planning & installation of drainage systems

Low volume flushing and its effect on UK drainage

- Trending towards lower litre WC flushing to reduce water consumption.

- Building Regulations Part H:
  - Only makes provision for major flush volumes of 5 litres or more.
  - States that consideration to increased risk of blockages should be given where major flush is less than 5 litres.

Low volume flushing and its effect on UK drainage

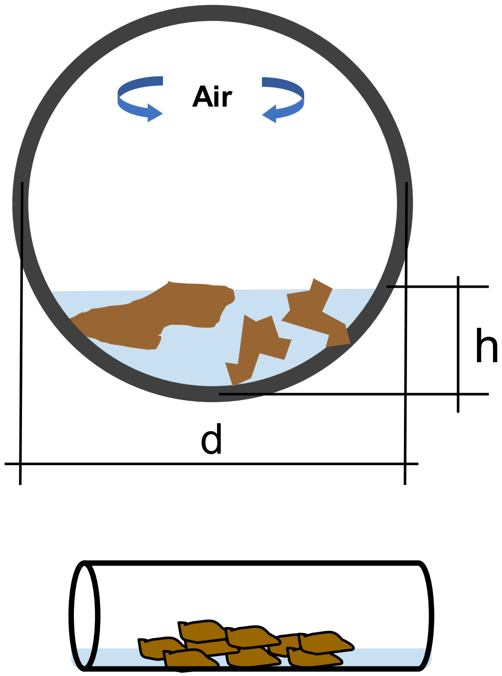
- UK design to BS EN 12056 doesn’t currently make any provision for lower volume flushing requirements.

- The UK’s default System III allows for full bore discharge pipes and a filling degree of 1.0 (100%).

- Currently BS EN 12056 only permits System II for a WC with 4 litre flush.

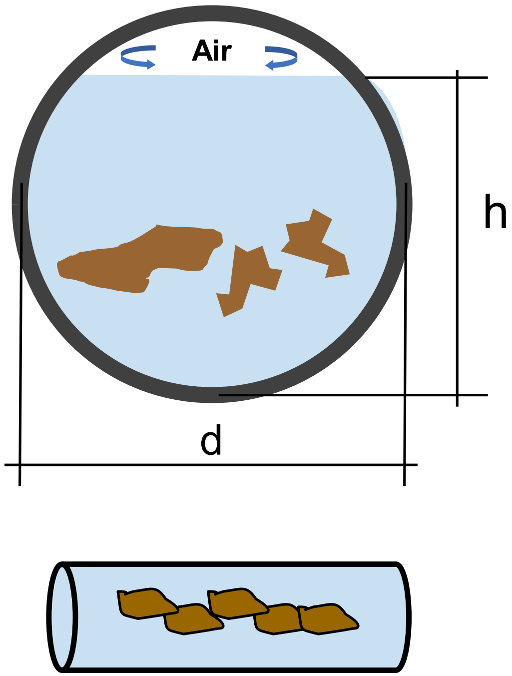
Filling ratio h/d of horizontal pipes

h/d below 0.5



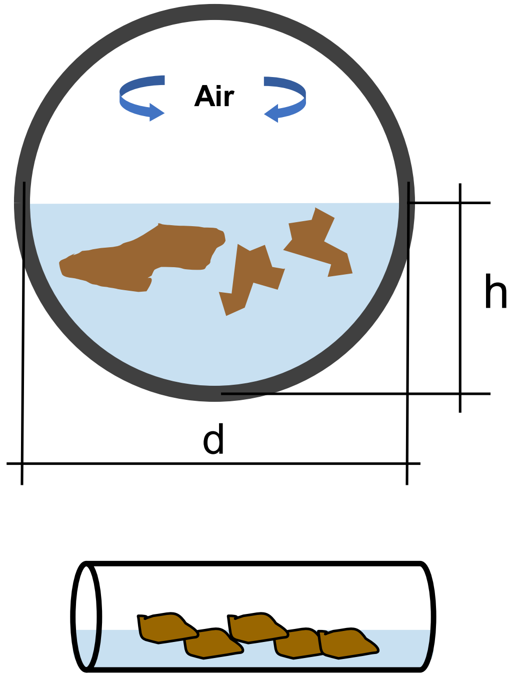
Insufficient flow

h/d above 0.8



No air = Siphonic

h/d 0.5 – 0.8



Sufficient flow

Appropriate size of discharge pipe is crucial for a good self-cleaning of the system.

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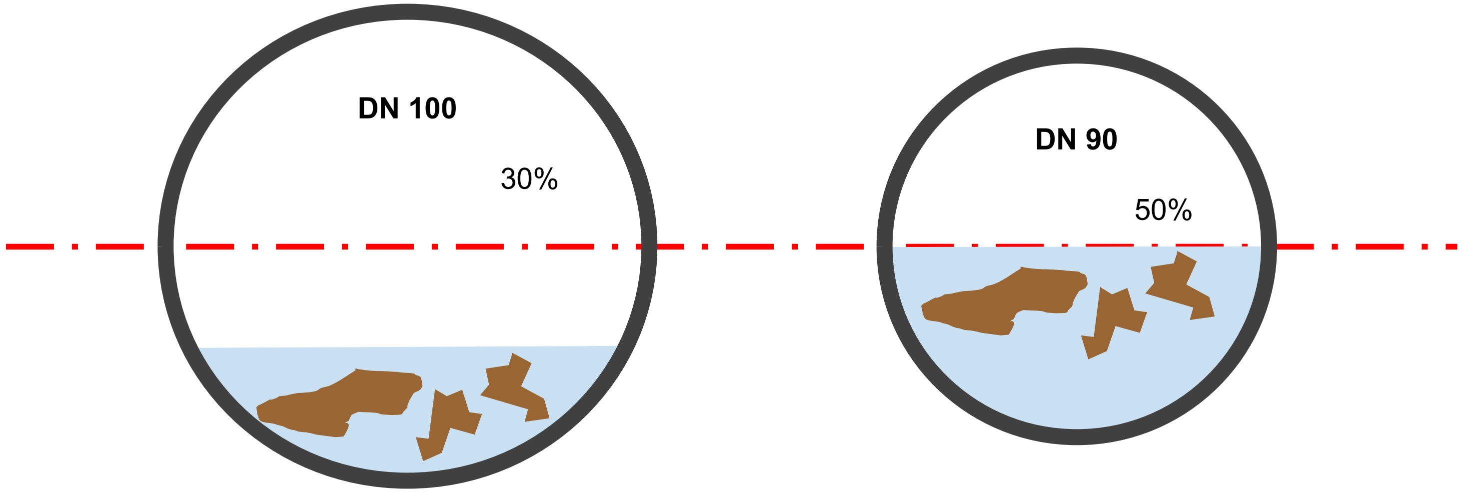
Low volume flushing and its effect on UK drainage

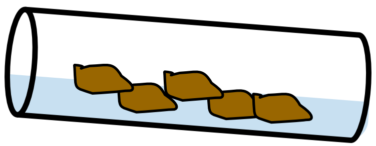
Filling-ratio between a dia. 110 and 90 mm pipe with 4.5 l



Smaller pipe allows better filling ratio

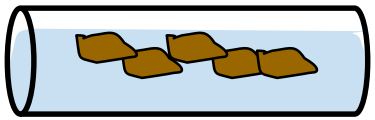
Slope in the pipes

Regular slope 1.25 - 2.5°
(Min. 1° - max. 5°)



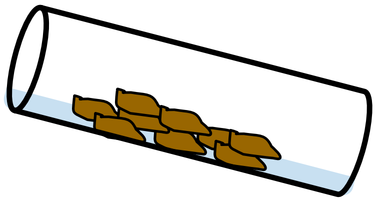
Good filling ratio

Insufficient slope
<1°



Filling ratio high,
no self-cleaning

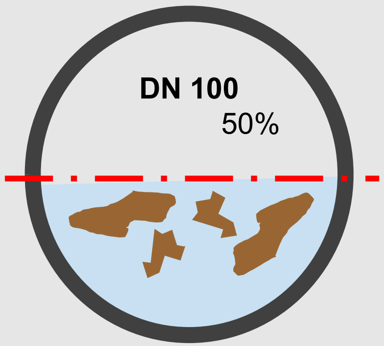
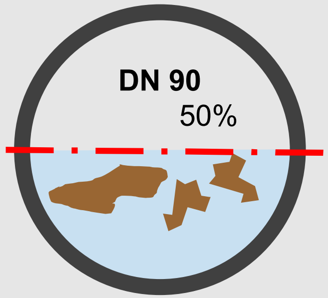
Excessive slope
>5°



Water discharges too quickly

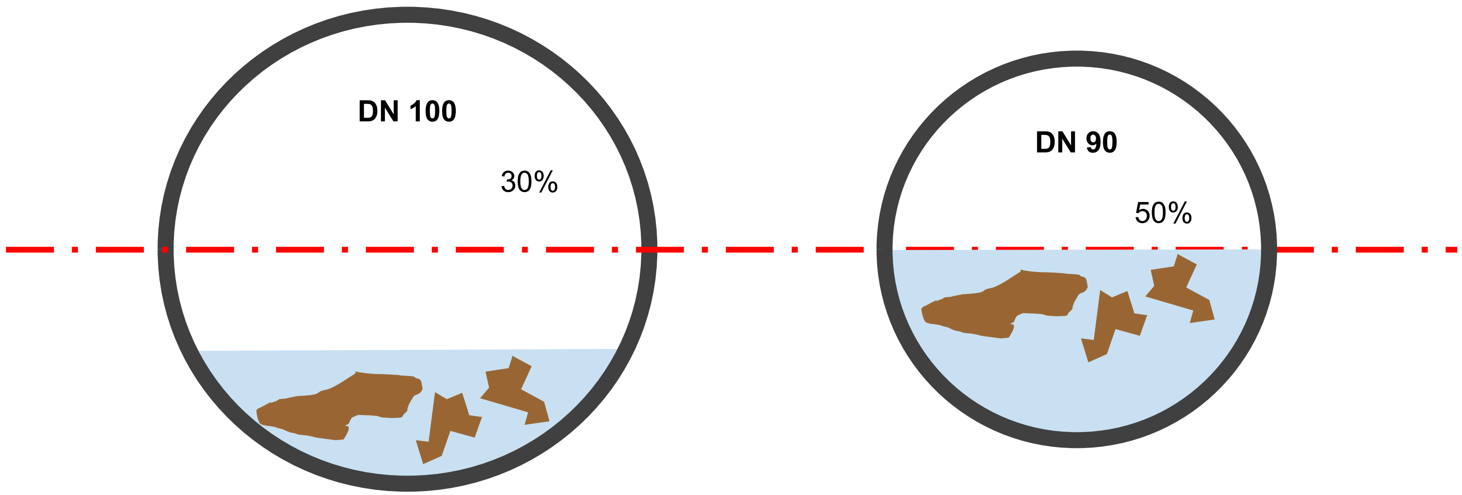
The horizontal pipes have to be installed with a regular slope.
The slope for pipes must be planned and installed with special care.

Key determining factors – 6l or 4.5l flush

	6 l	4.5 l
Decision factors	Standard solution	- Green Building (LEED, BREEAM, etc.) - Local authorities - Planner/Consultant - Owner/End-user - Facility Management
Cistern	Factory setting	Manual adjustment
Ceramic	Standard ceramic	4.5 l certified ceramic
Drainage system	**<u>DN100</u>** 	**<u>DN 90 or DN100</u>**  Based on : - Slope - Offsets - Amount of bends - Distance WC to stack - Pipe layout (e.g. cast in concrete)

Low volume flushing and its effect on UK drainage

Conclusion 4.5 l flush



Oversized systems may be vulnerable for blockages

A better solution for low volume flushing

Less water requires more expertise in planning & installation of drainage systems

Low litre flushing and its effect on UK drainage (video)

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Summary

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Summary

1. No body cares about drainage… until it becomes a problem
2. HDPE provides a great drainage solution
3. BS EN 12056-2 sets out layout principles of gravity drainage
4. Four potential system types, UK default is System III.
5. Five design criteria - SAGAA
6. Limitations to the use of primary vented stacks
7. Important to equalise positive & negative pressure fluctuations
8. Avoidance of cross-flow
9. Trend towards lower volume WC flushing
10. Low litre flushing needs special consideration at the design stage

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Dedicated to Specification

- Geberit Sales Ltd has a range of RIBA and CIBSE approved CPD's:
    - Creating the ideal washroom environment
    - Bathroom design behind the wall
    - Designing drainage without compromise BS EN 12056
    - Embedding acoustics into design
    - Siphonic rainwater systems

RIBA · CPD ASSESSED MATERIAL ·

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Clean disposal.

Thank you
Any questions?

Water, simply connected.

KNOW HOW INSTALLED

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