

Maths

Basic formulas and their uses

*Volume of a Storage Cistern = $l \times w \times h$

*This will calculate the Nominal Capacity of a Storage Cistern i.e. if the cistern was filled to the 'spillover level'. The Actual Capacity of a cistern is the level to which it will be filled in normal working conditions.

Volume of a hot water cylinder = $\pi r^2 \times h$

l = length

w = width

h = height

r = radius

$\pi = 3.142$

Pipe sizing formula (Thomas Box) = $q = \sqrt{\frac{d^5 \times H}{25 \times L \times 10^5}}$ q = discharge through pipe in litres per second

d = diameter of pipe / mm

H = head of water / m

L = total length of pipe / m

Si units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	celsius	°C
Thermodynamic temperature	kelvin	K
Electric current	ampere	A

Derived units

Quantity	Unit	Symbol	Equation
Force	newton	N	1N=1kg m/s ²
Pressure and Stress	pascal	Pa	1Pa=1N/m ²
Work, Energy and Heat	joule	J	1J=1Nm
Power	watt	W	1W=1J/s
Electrical potential	volt	V	1V=1W/A
Electric resistance	ohm	W	1W=1V/A

Hydrostatic table

1 litre of water weighs 1 kilogram
1 cubic metre of water = 1000 litres
Head of water in metres x 9810 = pressure (N/m ²)
Head of water in metres x 9.81 = pressure (kN/m ²)
Pressure in kN/m ² x 0.12 = head of water (m)
1 Bar = 1000 mbar = 10 Pa
1 mbar = 100N/m ² = 100 Pa

Drainage

A good sanitary pipework system should be designed and installed to provide the following attributes:

- Prevent the transmission of foul air into a building
- Minimise the frequency of any blockage, and provide adequate pipe access to enable the effective clearance of any such blockage
- Provide efficient conveyance of discharge from sanitary, kitchen, laundry and wash-down facilities to enable the correct function of each appliance

Therefore, sanitary pipework should be kept as short as possible, with few bends and an adequate gradient.

Limitations for ventilated branches

Appliance	Diameter mm	Maximum length m	Pipe gradient mm/m
Wash basin or bidet	32	3	18 min
	40	3	18 min
Bath or shower	40	3	18 min
Kitchen sink	40	3	18 min
Washing machine or dish washer	40	No limit	18 min
WC	75 / 100	No limit	18 min
Waste disposal unit	40 min	3	135 min
Floor drain	50 to 100	3	18 min

Water seal

Minimum depth of trap seal	
Use	Seal (mm)
Baths and showers that discharge into stack	50
Baths and showers on ground floor that discharge into grated gully	38
Wash basins with spray taps and no outlet plugs	50
Appliances with an outlet bore of 50mm or larger	50
All other appliances	75

Pipework

Colour code indications for pipework

Pipe content	Basic colour (150mm)	Colour code indication (100mm)	Basic colour (150mm)
Water			
Drinking	Green	Blue	Green
Grey Water	Green	Black	Green
Reclaimed Water	Green	Black – White - Black	Green
Cooling (primary)	Green	White	Green
Boiler feed	Green	Crimson – White – Crimson	Green
Condensate	Green	Crimson – Em Green - Crimson	Green
Chilled	Green	White – Em Green – White	Green
Heating < 100°C	Green	Blue – Crimson – Blue	Green
Heating > 100°C	Green	Crimson – Blue – Crimson	Green
Cold distribution	Green	White – Blue – White	Green
Hot distribution	Green	White – Crimson – White	Green
Fire distribution	Green	Safety Red	Green
Sea, river-untreated		Green	
Gas			
Natural	Yellow Ochre	Yellow	Yellow Ochre
Manufactured	Yellow Ochre	Em Green	Yellow Ochre
Oil			
Diesel fuel	Brown	White	Brown
Compressed air		Light Blue	
Vacuum	Light Blue	White	Light Blue
Steam		Silver Grey	

Service duct space

Pipework

Diameter mm	Space allowance mm
22	100 x 100
28	120 x 120
35	130 x 130
42	140 x 140
50	150 x 150
65	200 x 200
75	225 x 225
100	300 x 300
150	450 x 450
200	600 x 600

Regulations

The Water Regulations make provision for preventing:

- Contamination
- Waste
- Misuse
- Undue consumption
- Erroneous measurement

of water supplied by the water undertaker (water company).

Water companies have a duty to supply water which complies with the Water Quality Regulations, as part of the Water Industry Act, which ensures that a wholesome water, suitable for domestic or food production purposes and this quality of water is classified as fluid category 1.

The following table shows fluid categories 1 to 5.

Fluid category	Designation	Commentary
1	No impairment to quality	Wholesome water supplied by the water undertaker
2	Aesthetic quality impaired	Impairment due to change in temperature or a change in taste, odour or appearance. (Includes hot water.)
3	Slight health hazard	Has a concentration of substances of low toxicity such as, copper sulphate solution or similar chemical additives.
4	Significant health hazard	Has a concentration of toxic substances, including chemicals or pesticides and certain environmental organisms.
5	Serious health hazard	Has a concentration of pathogenic organisms, or toxic substances including human and animal waste.

Approximations (Rules of Thumb)

During the early stages of project design, plumbing engineers may be asked for information relating to the building services installations. This could even be before any plant, equipment or systems have been decided upon. Therefore there is a need to allow for access, installation and any future maintenance and these considerations have been accounted for when the following 'rules of thumb' were calculated, using a sound scientific background and simplified design equations. It is important to note that by nature, 'rules of thumb' are simplistic and should not be used for final project design calculations.

Heating System Operating Characteristics

Pipework

System type	Pipe size mm	Max Water velocity m/s
Conventional	15 - 50	0.75 – 1.5
Conventional	50>	1.25 – 3.0
Small bore	-	1.0
Microbore	-	1.2

Feed and Expansion Cistern sizes

Boiler output (kW)	Nominal cistern capacity (litres)	Pipe dia of feed & expansion (mm)	Pipe dia of open vent (mm)	Pipe dia of overflow (mm)
>25	45	15	22	22
25 – 45	70	22	28	28
45 - 60	90	22	28	35

Copper pipe

Size mm	Litres/metre run
15	0.145
22	0.320
28	0.539
35	0.835
42	1.232

Heating Pipework sizing

Copper pipe dia (mm)	Approx loading (W)
8	1500
10	2500
15	6000
22	13000
28	22000
35	34000

Temperatures

Comfort temperatures

Residential	Temperature °C
Living room	21
Bedroom	21
Kitchen	21
Entrance hall	21
Cloakroom	21
Commercial	
Office	20
Hotel room	22
Shop	18
Classroom	18

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Factories	Temperatures °C
Deskbound	19
Light work	16
Heavy work	13
Activity	
Seated at rest	21
Walking slowly	20

Outdoor climate

Winter design temperatures for heating

General buildings	-4oC
Single storey building	-3oC
Other buildings	-1oC

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