Section 6 – H/602/2697

Understand and apply domestic cold water system installation and maintenance techniques
H/602/2697 - Understand and apply domestic cold water system installation and maintenance techniques

This combination unit provides learning in the installation, maintenance, decommissioning and soundness testing of a basic range of cold water system/component types in dwellings and industrial/commercial properties (of similar size and scope to domestic dwellings). The unit covers systems in buildings up to 3 storeys in height with pipework up to 28mm diameter. The scope of the system is from the boundary stop valve into the property feeding the water outlets. Upon completion of the unit the learner will:

- **LO1.** Know the cold water supply route to dwellings
- **LO2.** Know the types of cold water system and their layout requirements
- **LO3.** Know the site preparation techniques for cold water systems and components
- **LO4.** Be able to apply site preparation techniques for cold water systems and components
- **LO5.** Know the installation requirements of cold water systems and components
- **LO6.** Be able to install cold water systems and components
- **LO7.** Know the service and maintenance requirements of cold water systems and components
- **LO8.** Be able to service and maintain cold water systems and components
- **LO9.** Know the decommissioning requirements of cold water systems and components
- **LO10.** Be able to decommission cold water systems and components
- **LO11.** Know the inspection and soundness testing requirements of cold water systems and components
- **LO12.** Be able to inspect and soundness test cold water systems and components.

Learning Outcomes highlighted in Red indicate that these are covered by practical tasks from the learner practical portfolio.
Learning Outcome 1

Know the cold water supply route to dwellings
There are five Assessment Criteria to Learning outcome 1:

AC1.1. State the key stages in the rainwater cycle.
AC1.2. Identify the various water supply sources and the typical properties of water from those sources
AC1.3. State the two main types of water supply to dwellings
AC1.4. Identify the mains water treatment process and typical mains water distribution system from treatment works to property.
AC1.5. Identify the uses of cold water supplied to dwellings

Water is a compound consisting of two atoms of hydrogen and one atom of oxygen. It is tasteless, colourless and odourless but in large amounts it appears to have a pale blue tint. Its chemical symbol is H₂O. Water, in one form or another, makes up around \(\frac{7}{10}\)ths of the earth’s surface and, because of its ability to absorb other elements and compounds is known as the ‘universal solvent’. This unique dissolving ability plays a vital role in plumbing systems and, as we shall see as we investigate water and its properties, can often determine how we install and maintain cold water installations.

**AC1.1 State the key stages in the rainwater cycle.**

There is no ‘new’ water on planet Earth. The water that exists on and below its surface has been here for around 4.2 billion years. Water is in constant movement in a cycle that is known to scientists as the hydrological cycle. We know it better as the ‘Rainwater cycle’.

**The rainwater cycle**

The rainwater cycle is a natural process where water is continually transferred from the atmosphere to the ground and back again to the atmosphere by means of three main transfer processes:

1. **Evaporation** – water is constantly evaporating from the oceans, lakes, rivers and streams into the air,
2. **Transpiration** – water moves through plants until it reaches the leaves where it evaporates into the atmosphere,

3. **Precipitation** – another word for rain. When water vapour precipitates, it condenses back into water droplets and falls to the earth as rain, hail and snow.

So, how does the rainwater cycle occur?

Heat from the sun evaporates water on the earth’s surface. The resulting water vapour rises as the air warms to form clouds, which are then carried by the prevailing winds around the planet. If the water vapour passes over land, more water vapour is added to the point where the cloud becomes saturated with water droplets and some of it falls back the ground as rain, hail, sleet and snow.

When it reaches the ground, some evaporates straight back into the atmosphere, some soaks into the ground, where it eventually reaches the geological water table or aquifer, and some runs into rivers and streams, where it eventually reaches the sea to begin the cycle over again.

**AC1.2 Identify the various water supply sources and the typical properties of water from those sources**

**Sources of Water**

3% of all the water on earth is fresh water and most of this is locked in the polar ice caps. Only 0.9% is ground and surface water. It is this 0.9%, some 1350 trillion litres, that supplies the entire planet with drinking water.

In the UK, only around 5% of all rainfall is collected for drinking water supplies. The rest flows into the sea or is filtered down through the earth’s surface where it collects in water bearing rocks called aquifers that exist deep below the Earth.

**Types of water**

As we discovered in Scientific Principles, water is classified as either hard or soft depending of the amount of calcium carbonate or calcium sulphate the water contains. Generally speaking, upland surface water and water that has filtered through peat tends to be very soft because CO₂ trapped in the peat is added to the water, which makes it very acidic. Water that is derived from sandstone aquifers is also very soft because of added CO₂. This kind of water is known as ‘plumbo-solvent’ because of its ability to dissolve lead. Soft water can be found in the North-West of the UK and parts...
of Scotland and is identified by the ease in which soap lathers. Soft water has a pH Value below 7 (pH 7 is neutral water).

Hard water can be either permanently hard or temporarily hard, depending on what the water has filtered through. Its hardness depends upon the amount of calcium in parts per million it contains. Hard water is classified as having more than 300ppm of calcium and has a pH Value above 7.

Generally, limestone filtered water is temporarily hard. It can be softened by boiling and leaves behind limescale deposits in pipes, taps and other components. Water supplied from Derbyshire and the Peak District is usually temporarily hard.

Permanently hard water filters through calcium sulphates and calcium bicarbonates. This cannot be softened by boiling. Soap will not lather in hard water areas.

**Underground water sources**

**Deep wells**

Usually dug by machine from below the shallowest impermeable strata. The water quality is generally good because it is extracted from deep below the earth’s surface.

**Shallow wells**

Historically, shallow wells have been dug by hand and only penetrate the first water-bearing strata or aquifer. They should be considered as dangerous because of the close proximity to leaking drains.

**Aquifers**

Aquifers are naturally occurring rock and sand formations that have the ability to hold vast quantities of usually clean water deep below the Earth’s surface. Most aquifers are permeable rocks such as sandstone and gritstone, gravel silt or clay that soak and hold water like a saturated sponge. Usually excellent quality but are vulnerable to contamination from farming nitrates and other pollutants, especially close to towns and cities.

**Artesian wells and springs**

The water from Artesian springs rise from under the ground under its own pressure in situations where the spring opening is below the level of the water table. The water is usually
very good quality as the water is filtered naturally through the rock due to its constant movement.

Bore holes

These are man-made, small diameter wells that are drilled directly through the Earth’s surface to a water source where the water is extracted for use when water main connection is not an option because of location. Very high quality of water, which should be carefully monitored before and during use to ensure the quality is maintained.

Surface water sources

Upland surface water

This is water that has collected in lakes and rivers without passing through the Earth’s surface. This is the main source of water for the North-West of England. It is naturally soft, acidic water and usually not contaminated.

Springs

These occur naturally, flowing directly from the Earth’s surface. Its purity is highly dependent on the distance it has travelled from its source.

Rivers

Rivers begin their life as small streams on high ground and become larger the further they travel. They usually terminate at the sea becoming more saline and brackish close to the coast. At their estuaries, rivers are tidal, being affected by the rise and fall of the tides. Inland, they are usually poor-quality water due to much industrial pollution with high treatment costs for human usage.

Canals

Canals are the products of the industrial revolution in the 18th and 19th Centuries, built for the purpose of transporting goods by barge from one end of the UK to the other. As the railways developed, they fell into disuse and neglect with many being filled in. Canals have been cleaned over the years with many being classified as sites of natural beauty. The water quality though, is usually poor with only limited amounts being used for agricultural and industrial processes.

AC1.3 State the two main types of water supply to dwellings

In the UK, around 97% of properties are fed with water directly from the mains cold water supply provided by one of the 22 water companies in the United Kingdom. The other 3% are fed with water from a private

The Water Act 2003 combines two previous pieces of UK legislation, the Water Industry Act 1991 and the Water Resources Act 1991. It introduced a series of changes to the regulation of the water industry across the UK. Enforced by the Environment Agency, the Water Act governs the following:

- Regulation and licencing of water and sewage companies by the Water Services Regulation Authority OFWAT.
- The obligations of the Water Companies and licenced water suppliers to ensure that they supply water that is fit for human consumption.
- The enforcement of those obligations by Department for the Environment, Food and Rural Affairs and the Drinking Water Inspectorate.
- The control of charges made by the Water Companies and licenced water suppliers to consumers by OFWAT.
- The protection of consumers (the public) by OFWAT

The Water Industry Act 1991, however, remains the primary national legislation for all water supplies in England and Wales and defines the powers and responsibilities of local authorities in relation to private water supplies and the definition of a relevant person(s).

Water supplied by a Water Undertaker

The supply of wholesome water to the majority of consumers is the responsibility of the UK water authorities. They are known as Water Undertaker’s. It is their responsibility to collect, clean, distribute and maintain the water supply in such a manner that the water is fit for human consumption under section 67 of the Water Industry Act 1991. Their responsibility ends at the external (boundary) stop tap to the property. From here, the responsibility rests with the owner of the property or the plumber.

Private water supplies

Private water supplies are water supplies that are not supplied by the Water Undertaker and, as such, are solely the responsibility of the owner and user of the water supply. This could be a single dwelling or multiple properties supplied from the same source. Private water may be supplied from a borehole, stream, river, spring or well.

The quality of the water supplied from private sources can be variable. Some sources offer good quality water where little treatment is necessary but others present a risk to health due to the water quality and require careful monitoring.

The responsibility for regulating private water supplies rests with the local authority but it is also vital that owners are aware of the potential risks. Owners should:
• Ensure that the source is protected against contamination from grazing animals and any contamination that may come from upstream.
• Install and maintain sufficient equipment that will maintain a satisfactory water quality.
• Ensure that the water is adequately disinfected before use.
• Ensure that any stored water is stored in such a way as to prevent contamination after storage but before use.
• Ensure that the water quality is tested regularly.

Ensuring water quality in the property

Under provisions laid down by the Water Industry Act 1991 and then later the Water Act 2003, the UK government introduced two pieces of legislation that regulate how plumbing systems are installed and maintained in domestic buildings in the UK. These are:

• The Water Supply (water fittings) Regulations 1999; and,
• The Private Water Supply Regulations 2016

The Water Supply (water fittings) Regulations 1999

On July 1st 1999, the government issued the Water Supply (Water Fittings) Regulations 1999 that standardised working practices across all areas of the United Kingdom. These were initially linked to BS6700 and then later to BSEN806: Specification for installations inside buildings conveying water for human consumption: PARTS 1 to 5 and BS 8558:2015: Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806.

The Water Supply (water fittings) Regulations were written under section 74 of the Water Industry Act 1991 to ensure that the systems of plumbing installed in properties prevent the following:

• Contamination of water
• Wastage of water
• Misuse of water
• Undue consumption of water
• Erroneous metering of water

It should be remembered that these regulations only apply to water that has been supplied by a Water Undertaker and do not apply to water supplied from a private source.

A free copy of the regulations can be downloaded from www.opsi.gov.uk/si/si1999/19991148.htm.

The Private Water Supply Regulations 2016

These ensure that water supplied from a private source are safe for people to drink. Changes from the 2009 Private Water Supply Regulations now classify private water supplies into four categories:
Large supplies serving commercial and public buildings such as hotels, restaurants, nursing homes, bed and breakfast establishments, village halls and large domestic users using more than 10m$^3$/day or supplying more than 50 people per day on average.

Small supplies serving two or more domestic properties but with no commercial usage, using less than 10m$^3$/day or fewer than 50 people per day on average.

Single property supplies where water is supplied for domestic purposes only.

Private distribution networks. The scope of the regulations now includes networks where the water is distributed further beyond the responsibility of the licenced water company. These include such properties as caravan parks, industrial estates or country estates or where water is distributed by tanker.

The Role of local authorities in regulating private water supplies

The local authority acts as the regulator for the private water supplies in their area and have statutory duties under the PWSR. Local Authorities must:

- Conduct a risk assessment on every property with private water supply in their area.
- Undertake monitoring in order to determine compliance with water standards.
- Provide monitoring data to the Drinking Water Inspectorate (DWI).

The local authority has enforcement powers to ensure that a water supply is improved, should it fall below the minimum cleanliness requirement, by the relevant person(s) who control that supply.

The Role of Drinking Water Inspectorate (DWI) in regulating private water supplies

The DWI plays a statutory role in acting as technical advisors to Local Authorities in relation to the implementation of the Private Water Supplies Regulations 2016. This includes technical and scientific assistance on all aspects of drinking water quality on both public and private supplies.

The Water Supply (water quality) Regulations 2016

In the United Kingdom, all water, whether from a private source or supplied by a water undertaker, must comply with the EU Drinking Water Directive 98/83/EC. It is the duty of every member state to implement rules that reflect the directive, which must meet the minimum European Legislation. This legislation reflects the recommendations of the World Health Organisation (WHO).

The law requires that all drinking water is wholesome and clean. It sets down minimum acceptable concentrations of potential contaminants. It states that:

"Water is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health."

More information can be found at http://www.water.org.uk/
AC1.4 Identify the mains water treatment process and typical mains water distribution system from treatment works to property

Before water can be considered fit for human consumption, it must undergo several stages of cleanliness. These stages are:

- Screening
- Flocculation
- Sedimentation
- Filtration
- Disinfection

These are known as the water treatment process.

The water treatment process

Screening

First, the water is passed through a series of coarse meshes to remove large debris such as leaves, plant material and other fragments.

Flocculation

Here, a chemical coagulant is added to the water to act as a binding agent to remove colour, turbidity and algae. This process also allows any dissolved metals such as aluminium and iron to precipitate. This leads to the formation of a ‘floc’ which can then be removed by other processes.

Turbidity – cloudiness or haziness due to millions of microscopic particles that would normally be invisible to the naked eye.

Sedimentation

Sedimentation is designed to slow down the velocity of the water to allow any solid matter, such as grit, mud and decaying vegetation missed by the screening process, to sink under gravity to the bottom of the sedimentation tanks. This process further reduces turbidity and bacteriological content of the water. After further sedimentation, the water is pumped to a storage reservoir before being filtered.

Filtration

There are several types of filters used to filter drinking water:
- **Slow sand filters** – these provide the most common method of filtration. Here, water flows over a bed of graded sand. The sand is full of minute algae growth which assist in the purification process of the water by consuming any contaminates present. This eventually leads to a build-up of sludge, called a *schmutzdecke* that is very effective at removing the various impurities in the water. After around 6 to 10 weeks, the sludge is removed as the filtering slows to a point where it is not effectively allowing water to pass through it. The use of tandem filters means the filtration process can continue whilst cleaning is taking place.

- **Rapid sand filters** – mainly used to remove floc after the flocculation process but can effectively be used to remove algae, iron and manganese from raw water.

- **Pressure filters** – here the filter bed is enclosed in a cylinder pressure vessel. They are sometimes used where the need to maintain water pressure without the aid of a pump.

**Disinfection**

The final stage of the water treatment process is disinfection. This is where a small amount of chlorine, usually less than 1 milligram per litre of water, is added to kill off any bacteria that may have escaped all the other processes. This is usually injected into the water just before it enters the water supply.

**Distribution of water supply**

After the water has gone through the treatment process, it is distributed to homes and businesses throughout the UK by one of two ways:

- By gravity distribution
Gravity distribution

Gravity water distribution begins when the reservoir is sited on high ground. The water, once it has gone through the treatment process, is fed to the distribution network by gravity. No pumping is necessary as the head of water created by the vertical distance between the reservoir and the outlets is sufficient to create the pressure required at the taps and outlets in homes, offices and factories.

Pumped distribution

After going through the water treatment process, the water is pumped to a service reservoir held on a tower. From here, the water distributes to the water network via gravity. Again, it is the vertical distance from the reservoir to the outlets that creates the head of pressure.

Water towers are used where there is insufficient pressure from the main itself. This could be due to the size of the water main or the lack of vertical distance from the supply to the outlets.

Distribution of water to cities, towns and villages

Water is supplied to cities, towns and villages via a grid network of pipes. These are known as trunk mains and will vary in diameter depending on the population, the purpose of the cold water main or the likely demand for water in a particular area. The pipe size of the trunk mains is generally between 75mm to 2.3m
depending on the number of outlets and the size of the area

<table>
<thead>
<tr>
<th>Population</th>
<th>Size of main</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 million</td>
<td>1.05m to 1.20m</td>
</tr>
<tr>
<td>200,000</td>
<td>0.75m</td>
</tr>
<tr>
<td>5000 - 20,000</td>
<td>0.2m to 0.3m</td>
</tr>
</tbody>
</table>

Many of the trunk mains in the UK were laid during the Victorian area and, consequently, are coming to the end of their useful lives. Old water mains, mainly made of ductile iron, are systematically being replaced with modern equivalents that are better able to cope with modern water demands as towns and cities grow in size.

In residential areas, the pipework is laid out beneath the streets in a grid system. This ensures that repairs to water mains do not interrupt the supply of water to the majority of people in the area and that only the minimum amount of disruption and inconvenience is caused to as few people as possible.

### AC1.5 Identify the uses of cold water supplied to dwellings

**Wholesome water for domestic purposes**

Water that is supplied directly from the water main has several uses:

- Personal hygiene – washing, bathing and ablutions
- Cooking and food production
- Drinking

**Recycled water**

Recycled water is water that has been previously used for another purpose such as bathing, washing etc, and rainwater that has been collected in special cisterns but has not been treated to drinking water standard. Both of these types of water are not fit for human consumption but can be used, with care, inside and outside the dwelling for limited purposes:

- WC flushing,
- Water for outdoor use i.e. watering the garden or car washing
- Clothes washing.
Recycled water systems MUST NOT in any way be cross connected with the cold water mains supply
Learning Outcome 2

Know the types of cold water system and their layout requirements
There are nine Assessment Criteria in Learning Outcome 2:

**AC2.1.** State the cold water system pipework features between the water undertaker’s main and the main internal stop valve in dwellings

**AC2.2.** Identify the type of cold water system from layout diagrams.

**AC2.3.** State the factors which affect the selection of cold water systems for dwellings

**AC2.4.** State the typical pipe sizes used in cold water systems in dwellings

**AC2.5.** State the factors that can lead to backflow from cold water outlets and equipment in dwellings.

**AC2.6.** Identify the standard backflow prevention devices that are used in cold water systems in dwellings supplying water to appliances

**AC2.7.** Identify the working principles of cold water system components

**AC2.8.** State the system layout features for protected plastic storage cisterns

**AC2.9.** State the methods of linking cold water storage cisterns for use in dwellings.

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**AC2.1 State the cold water system pipework features between the water undertaker’s main and the main internal stop valve in dwellings**

**Connections to water mains**

There are many ways in which a connection for a water main to a property can be made. Many of these methods will depend on the material from which the main is made. Water mains made from cast iron, PVCu, polyethylene and even cement lined asbestos are not uncommon in the United Kingdom. It is important to remember that the water main is the property of the Water Undertaker in the area and any connections, maintenance and repairs must only be made by the water undertaker or its contractors.

**Common connection methods**

In many instances, the water main will be made from spun cast iron. Connections to cast iron are made through a self-drilling, self-tapping machine, which drills a hole in the water main, threads the hole and installs the brass ferrule while the main is still under full pressure.

For water mains made from PVCu, polyethylene and cement lined asbestos, a brass strap type ferrule is used, such as the one shown in the photograph.

*A brass strap and ferrule*
**The Communication Pipe**

The communication pipe is installed by and remains the property of the water undertaker. It connects to the water main via a ferrule and terminates at the property boundary. At the boundary, it is connected to a stop valve known as the main external stop valve (often called the boundary stop tap). It includes a goose neck bend at the water main end. This allows for any settlement of the road or pavement.

**The Supply Pipe**

The supply pipe runs from the boundary of the property to the building, terminating inside the building with a screw down stop tap manufactured to BS1010. It must be installed at a depth of between 750mm and 1350mm. A drain-off valve must be installed immediately above the internal stop valve. It is the responsibility of the property owner. Together, the communication and supply pipes form the building water service.
From the street to the dwelling

The supply pipe to buildings may be arranged in different ways and this sometimes reflects the age of the property. Look at the drawing below:

1. This is the preferred method of cold water supply as no other property is connected to any part of it.

2 and 3. Often found in older properties where the communication pipe is long. Here the communication pipe connection to the water main would be one size larger than for an individual property to compensate for the extra connection.

4 and 5. Commonly known as a communal supply, this kind of connection is usually found in Victorian terraced houses and local authority built housing up to the early 1960s. As many as 4 houses may be connected to a common supply pipe. It is usually the cause of low flow rate in many houses with this type of connection.
All modern water supplies are installed using Medium Density Polyethylene pipe of 25mm size for houses and bungalows. This increases for large domestic dwellings and industrial/commercial properties. Copper pipe to BS EN 1057 R220 can also be used but often the high cost of the copper pipe prevents this. High Density Polyethylene pipe (coloured black) was used up until the early 1980s and copper pipe was used from the late 1940s. The housing boom of the Victorian era saw hundreds of miles of lead pipe used of various sizes and weights, much of which still exists today.

With all new installations, a water meter is fitted either at the boundary of the property or in a meter housing on the outside of the building. Externally fitted meters are usually housed in a ‘groundbreaker’ type meter box.

For existing properties and refurbishments, an internal water meter installation is acceptable but it must be fitted in accordance with the Water Supply (water fittings) Regulations 1999 so that erroneous metering is prevented by installing any drain-off valve above the meter so that water may not be drawn before the meter installation as shown in the drawing left.

Once inside the property, the water supply should have a screwdown type stop tap manufactured to BS 1010-2 installed just above finished floor level so that the whole building can be turned off. The Water Regulations tell us that:

As far as is reasonably practicable, a stop valve should:

a. Be located inside the building
b. Be located above floor level, and;
c. Be as near as possible to the point where the supply enters the building, and;
d. Be so installed that its closure will prevent the supply of water to any point in the building.

The diagram illustrates the three methods of entering a cold water supply pipe into a building depending on the type of ground floor built into the property. The water undertaker’s recommend that no more than 150mm of MDPE pipe be showing above floor level as MDPE is susceptible to ultra violet light and will decompose if exposed for long periods.

There are many stop taps that are manufactured to BS1010-2 and when fitted to mains cold water supply, these must be made of a corrosion resistant brass or gunmetal to prevent de-zincification. Again, the Water Regulations are very clear:

> Every water fitting shall be immune to or protected from corrosion by galvanic action or by any other process which is likely to result in contamination or wastage of water.

*Schedule 2 Regulation 3.*

When installing Cold water systems, all fittings that are made of a copper alloy should be either made of gunmetal or de-zincified brass. Both metals are easily identifiable as fittings carry a specific mark identifying the fact that they are corrosion resistant. A drain off valve manufactured to BSEN1254 should be installed immediately above the internal stop valve to the building to allow for complete draining of the system.

![Corrosion Resistant Mark](image)
AC2.2 Identify the type of cold water system from layout diagrams.

AC2.3 State the factors which affect the selection of cold water systems for dwellings

There are a number of cold water installation designs that are in use in the United Kingdom. Two of these systems are commonly used in domestic dwellings:

1. Direct cold water system
2. Indirect cold water system

Direct Cold Water System

The Direct System of cold water supply is the most common system in use in the UK. With this system, all of the cold water outlets are fed with water directly off the water undertaker’s mains cold water supply. Storage of cold water is only required if the hot water supply is taken from a low pressure hot water storage vessel.
Storage is not required when the hot water supply is supplied from an unvented hot water storage vessel or a combination (combi) boiler/instantaneous gas hot water heater. The installation is cheap and quick to install. Good flowrate and pressure are a necessity with this system when instantaneous hot water supply is used.

The direct system is mainly used in small to medium sized dwellings where there are a limited number of outlets.

### Table 1: Direct Cold Water installations

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is the most cost effective cold water system installation</td>
<td>The water pressure may drop at times of peak demand</td>
</tr>
<tr>
<td>Mains cold water is available at all cold water taps and outlets</td>
<td>There is no cold water storage if the cold water main is under repair</td>
</tr>
<tr>
<td>It requires less pipework than any other installation</td>
<td>Can be noisy due to the high flow rates and pressures of the water supply</td>
</tr>
<tr>
<td>Little or no structural support is required for cisterns in the roof space</td>
<td>Greater risk of contamination to the cold water main due to the fact that all connections, taps, outlets and appliances are connected direct to the mains supply</td>
</tr>
<tr>
<td>The most suited installation where mains cold water is required by appliances and components, such as electric showers and unvented hot water systems.</td>
<td>Greater wear on taps and valves, which can increase the noise within the system</td>
</tr>
<tr>
<td>Smaller pipe sizes can be used in the majority of installations</td>
<td>Water hammer can be a problem where poor installation practice has been used or where taps and valves are worn or faulty</td>
</tr>
<tr>
<td>Good pressure at ALL cold water outlets</td>
<td>Greater condensation build-up on pipework that is often mistaken for a leak</td>
</tr>
<tr>
<td></td>
<td>Can cause a lot of water damage due to the high pressure and flowrate, should there be a leak</td>
</tr>
</tbody>
</table>

**Indirect cold water system**

With the indirect system of cold water supply, the kitchen sink is the only appliance that is supplied with water direct from the water undertaker’s water main. All other appliances, bath, washbasin and WC, are supplied with water from a cold water storage cistern in the roof space. Because of the increased need for stored cold water, the size of the cistern will also increase. The cistern should be installed as high as possible to increase the system pressure.

This system is designed for properties in low water pressure areas, where the water undertaker’s cold water main is insufficient to meet the property’s full cold water pressure and flow rate requirement. The system also has a back-up of stored water for use in the event of mains cold water failure.
Table 2: Indirect Cold Water installations

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced risk of contamination</td>
<td>The rising main must be protected against backflow from the cistern</td>
</tr>
<tr>
<td>Reduced risk of water hammer and reverberation noise</td>
<td>Greater risk of frost damage of pipework and cisterns in the roof space</td>
</tr>
<tr>
<td>Low pressure supply reduces the impact of leakage damage</td>
<td>A large amount of water storage is needed</td>
</tr>
<tr>
<td>Reduces the demand on the cold water main at times of peak demand</td>
<td>Cisterns use a lot of storage space in the roof</td>
</tr>
<tr>
<td>Pipework can be sized to give very good flowrates despite the lack of pressure</td>
<td>More structural support required to carry the weight of the cisterns when full of water</td>
</tr>
<tr>
<td>Shower valves on low pressure supplies may be</td>
<td>Greater cost of installation</td>
</tr>
</tbody>
</table>
AC2.4 State the typical pipe sizes used in cold water systems in dwellings

**Direct systems**

Generally speaking, most direct systems utilise a 15mm rising main with 15mm pipework to all cold water outlets. This is sufficient for small installations where a combination boiler supplying hot water is installed, without en-suite bathrooms and shower rooms.

Where the hot water is supplied through an open vented hot water storage system, the cold water rising main will terminate at a cold feed cistern normally positioned in the roof space. The water storage capacity of the cistern must be at least the storage capacity of the hot water storage vessel.

For those installations where an unvented hot water storage system is to be connected, a 22mm minimum cold water rising main should be installed. This is because unvented hot water storage systems require a far greater flowrate which can only be supplied through a larger size pipe. Installations where the hot water is supplied direct from the mains cold water supply through a mains pressure hot water heater or unvented hot water storage system, the number of outlets is effectively doubled and this will increase the size of the mains cold water supply pipework.

Occasionally, a 28mm rising main may be required depending on the size of the property and the number of outlets being supplied.

**Indirect systems**

The indirect system of cold water supply is designed for areas where the cold water supply pressure is low and not capable for supplying the full water requirements of the system design. It utilizes a 15mm cold water rising main, feeding cold water storage cisterns in the roof space. Only the kitchen sink and possibly any downstairs cloakroom or utility room are taken directly off the cold water main. All other outlets are fed by a low pressure supply, minimum 22mm pipework and often 28mm pipework depending on the number of outlets, from the storage cisterns. This is known as the cold distribution pipework. 22mm pipework should be supplied to the bath to give a good flowrate.

To give an adequate pressure, the cold water storage cisterns should be supplied with equal pressures and flowrates. Reserve water in the cistern should the cold water mains fail, more pipework needed, reduced pressure at outlets and taps.
positioned as high as possible. They must also be protected against undue warming and frost.

The amount of cold water stored in the roof space will need to be carefully calculated as, in most cases, the cisterns will also supply cold water to an open vented hot water installation and so will need to be large enough to supply both cold water and hot water household needs.

AC2.5 State the factors that can lead to backflow from cold water outlets and equipment in dwellings

Before we investigate backflow, back pressure and back syphonage, we must first look at why these situations can be dangerous in domestic cold water systems.

Fluid categories of water and uses of water supplied to dwellings

Water that is not classified as clean, cold, wholesome and potable by a water undertaker must be regarded as a potential hazard. Because of this, schedule 1 of the Water Supply (water fittings) Regulations classify water into five fluid categories. The following descriptions are given in Schedule 1 of the Water Supply (Water Fittings) Regulations 1999:

<table>
<thead>
<tr>
<th>Fluid category 1</th>
<th>Wholesome water supplied by the undertaker and complying with the requirements made under section 67 of the Water Industry Act 1991/ the Water Supply (Water Quality) (Scotland) Regulations 1990 and any amendment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid category 1 – this is water supplied by a Water Undertaker under section 67 of the Water Act 1991. It must be clean, cold and wholesome and suitable for domestic use and food preparation purposes. Wherever possible, drinking water should be supplied from a water undertaker’s mains supply.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fluid category 2</th>
<th>Water in fluid category 1 whose aesthetic quality is impaired owing to –</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid Category 2 – the changes in fluid category are aesthetic only and do not constitute a health risk. They may occur in:</td>
<td></td>
</tr>
<tr>
<td>o Water heated in a hot water secondary system.</td>
<td></td>
</tr>
<tr>
<td>o Mixed water containing fluid categories 1 and 2 that is discharged from combination taps or showers.</td>
<td></td>
</tr>
<tr>
<td>o Water that has been softened by a domestic water softener.</td>
<td></td>
</tr>
</tbody>
</table>

| Fluid category 3 | Fluid which represents a slight health hazard because of the concentration of substances of low toxicity, including any fluid which contains – |

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Author: BPEC Ltd. Editor: BPEC Ltd. Design: BPEC Ltd
Fluid Category 3 – typical situations:

1. In houses, apartments and other domestic dwellings:
   a. Water in the primary circuits of central heating systems irrespective of whether chemicals have been added or not.
   b. Water in washbasins, baths and shower trays.
   c. Clothes and dishwashing machines.
   d. Home dialysis machines
   e. Hand-held garden hoses with a flow controlled spray or shut-off valve.
   f. Hand-held fertilizers.

2. In premises other than single occupancy domestic dwellings:
   a. Domestic fittings and appliances such as washbasins, baths, or showers installed in commercial, industrial or other premises may be regarded as fluid category 3. However, if there is a potential for a higher risk, such as a hospital, medical premises or other similar establishment, then a higher fluid category risk must be applied in accordance with the regulations.

3. House garden or commercial irrigation systems without insecticides.

Fluid Category 4

Fluid which represents a significant health hazard because of the concentration of toxic substances, including any fluid which contains –

- Chemical, carcinogenic substances or pesticides (including insecticides and herbicides), or
- Environmental organisms of potential health significance

Fluid Category 4 – Typical situations:

1. General:
   a. Primary circuits of central heating systems in properties other than a single occupancy dwelling.
   b. Fire sprinkler systems using anti-freeze chemicals

2. House gardens:
   a. Mini irrigation systems without fertilizer or insecticides, including pop-up sprinkler systems and permeable hoses.

3. Food processing:
   b. Dairies.
   c. Bottle washing plants.

4. Catering:
   a. Commercial dishwashers.
   b. Refrigerating equipment

5. Industrial and Commercial installations:
a. Dyeing equipment.
b. Industrial disinfection equipment.
c. Photographic and printing applications.
d. Car washing and degreasing plant.
e. Brewery and distilling processes.
f. Water treatment plant or softeners that use other methods than salt.
g. Pressurised fire-fighting systems.

**Fluid category 5**
Fluid which represents a serious health hazard because of the concentration of pathogenic organisms, radioactive or very toxic substances, including any fluid which contains –
- Faecal material or other human waste:
- Butchery or other animal waste: or
- Pathogens from any other source.

**Fluid Category 5 – Typical situations:**

1. **General:**
   a. Industrial cisterns and tanks.
   b. Hose union bib taps in a non-domestic installation.
   c. Sinks, WC pans, urinals and bidets.
   d. Permeable pipes in any non-domestic garden whether laid at or below ground level.
   e. Grey water recycling systems.

2. **Medical:**
   a. Laboratories.
   b. Any medical or dental equipment with submerged inlets.
   c. Bedpan washers and slop hoppers
   d. Mortuary and embalming equipment.
   e. Hospital dialysis machines.
   f. Commercial clothes washing equipment in care homes and similar premises.
   g. Baths, washbasins, kitchen sinks and other appliances that are in non-domestic installations.

3. **Food processing:**
   a. Butchery and meat trade establishments
   b. Slaughterhouse equipment.
   c. Vegetable washing.

4. **Catering:**
   a. Dishwashing machines in healthcare premises and similar establishments.
   b. Vegetable washing.

5. **Industrial/commercial:**
   a. Industrial and chemical plants.
   b. Laboratories.
c. Any mobile tanker or gulley cleaning vehicles.

6. Sewerage treatment works and sewer cleaning:
   a. Drain cleaning plant.
   b. Water storage for agricultural applications.
   c. Water storage for firefighting systems.

7. Commercial agricultural:
   a. Commercial irrigation outlets below or at ground level and/or permeable pipes, with or without chemical additives.
   b. Insecticide or fertiliser applications.
   c. Commercial hydroponic systems.

The distinction between fluid category 4 and fluid category 5 is difficult to distinguish since both categories constitute a serious risk to health. In general, however, water classified as fluid category 4 has the potential to cause harm over a period of days to weeks to months, whereas water classified as fluid category 5 may cause harm after only a very short exposure of minutes to hours to days or even a single exposure.

It must also be remembered that it is forbidden for water from any other fluid category to come into contact with water under fluid category 1.

**Backflow prevention**

Schedule 2 paragraph 15 of the Water Supply (water fittings) Regulations 1999, deals with backflow prevention. Backflow is simply the reversing of the normal direction of the water flow and can be as a result of backpressure (where the water pressure downstream is greater than the water pressure upstream) or back syphonage (where the water is sucked backwards through the pipework due to sudden loss of pressure). This can lead to contamination of the water undertakers mains cold water supply. See the diagrams above.
Cross connection of wholesome water with water from other sources can be another major source of contamination by back pressure and back syphonage. Cross connections can occur in the home easily simply by connecting mixer taps on hot and cold water supplies. If the mixing tap or valve is a true mixer (not a bi-flow mixer), then a cross connection between hot and cold supplies is deemed a cross connection between a fluid cat. 1 water (cold) to a fluid cat. 2 water (hot). In this instance, the simple installation of a single check valve on the cold supply will prevent contamination. However, not all back flow situations are so easily sorted out.

**Upstream and downstream explained**

AC2.6 Identify the standard backflow prevention devices that are used in cold water systems in dwellings supplying water to appliances

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Risk</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baths</td>
<td>Back pressure and back syphonage through mixer taps. Fluid category 2 and 3</td>
<td>Where both hot and cold supplies are taken from the mains cold water supply and no shower hose exists, <strong>Type EA/EB single check valve</strong> installed on the hot and cold supplies. Where the supplies come from unbalanced sources e.g. high pressure cold and low pressure hot and no shower hose exists, <strong>Type EA/EB single check valves</strong> on both hot and cold supplies. Where a shower hose exists e.g. a bath/shower mixer tap, <strong>Type EC/ED double check valve</strong> installed on the cold supply. <strong>AUK2 airgap</strong> at the appliance.</td>
</tr>
<tr>
<td>WCs</td>
<td>Fluid category 5</td>
<td><strong>AUK1 air gap</strong></td>
</tr>
<tr>
<td>Over the rim bidets</td>
<td>Fluid category 5</td>
<td><strong>AUK3 airgap</strong></td>
</tr>
<tr>
<td>Wash hand basins</td>
<td>Back pressure and back syphonage through mixer taps. Fluid category 2 and 3</td>
<td><strong>AUK2 airgap</strong> at the appliance. Where both hot and cold supplies are taken from the mains cold water supply, <strong>Type EA/EB single check valve</strong> installed on the cold supply.</td>
</tr>
<tr>
<td>Sinks</td>
<td>Fluid category 5</td>
<td><strong>AUK3 airgap</strong></td>
</tr>
<tr>
<td>Mixer taps</td>
<td>This is dependent on the appliance that the tap is</td>
<td><strong>AUK2 airgap</strong> – washbasins and baths</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>AUK3 airgap</strong> – kitchen, utility and cleaners</td>
</tr>
</tbody>
</table>
sinks
All mixer taps connected to the mains cold water supply – **Type EA/EB single check valve** (minimum)

<table>
<thead>
<tr>
<th>Outside taps</th>
<th>Fluid category 3</th>
<th><strong>Type EC/ED Double check valve</strong></th>
</tr>
</thead>
</table>

**Shower mixer valves/ instantaneouse showers**
- Back pressure and back syphonage through mixer valves. Fluid category 2 and 3
- Back syphonage through instantaneous electric showers. Fluid category 3

Where both hot and cold supplies are taken from the mains cold water supply and the shower hose is restrained by a retaining ring, **Type EA/EB single check valve** installed on the cold and hot supplies.

Where a shower hose exists e.g. a shower mixer valve, **Type EC/ED double check valve** installed on the cold supply.

Shower valves connected to low pressure cistern fed hot and cold supplies do not require backflow protection.

**Refrigerators, washing machines and dishwashers.**

- Fluid category 3

Most domestic dish washing and clothes washing machines have inbuilt airgaps to accommodate fluid category 3. Where no such air gap exists, the cold water supply must be protected with a **Type EC/ED double check valve**

Below are examples of the backflow prevention devices listed in the above table:

![AUK1 air gap with interposed cistern](image-url)
AC2.7 Identify the working principles of cold water system components

Baths
Connections to baths vary depending on the position of the taps. For domestic installations, bath taps have a ¾ inch BSP male thread for connection with a ¾” x 22mm tap connector.

WCs

All WCs are provided with a float operated valve to the WC cistern. The float operated valve (FoV) for WC cisterns can either be bottom fed or side fed and all have ½” BSP male threads to allow connection to the water supply via a ½” x 15mm tap connector. The FoV should be provided with a servicing valve for maintenance, repair and replacement.

Over the rim bidets

Over-rim bidets installed in domestic premises can either have single or combination taps installed. All taps fitted to over-rim bidets must have an AUK2 air gap provided between the outlet of the tap and the spill-over level of the bidet. The Water Regulations Advisory Scheme (WRAS) Installation Requirement Note IRN R010 also stipulates that the water supply to combination taps shall have reasonably balanced pressures. Where unbalanced water pressures are used, then approved single check valves must be fitted immediately upstream of both hot and cold supplies.

Wash hand basins

Wash hand basins installed in domestic premises can either have single or combination taps installed. Single taps have ¾” male BSP threads while combination taps often have 10mm copper tails. All taps fitted to wash basins must have an AUK2 air gap provided between the outlet of the tap and the spill-over level of the basin.

Again, Installation Requirement Note IRN R010 also stipulates that the water supply to combination taps shall have reasonably balanced pressures. Where unbalanced water pressures are used, then approved single check valves must be fitted immediately upstream of both hot and cold supplies.

Sinks

All sinks for domestic purposes, whether manufactured from ceramics or stainless steel must have taps that give an AUK3 air gap. Sink taps can either be single high-neck pillar taps, combination taps or wall mounted bib taps, depending upon the installation requirements. The water in sinks should be
regarded as fluid category 5 (see textbook 1). Single taps have ¾ “ male BSP threads while combination taps often have 15mm copper tails.

**Urinals**

Urinals, although not a domestic appliance, require careful consideration. Connecting a urinal to the water supply can be completed in one of either two ways:

- Via an automatic flushing cistern, or;
- A manual or automatic flushing valve

Urinals using automatic flushing cisterns must be installed in such a way that does not constitute a wastage of water. WRAS note IRN R075 states that urinals using automatic flushing cisterns should be installed to give a flush rate not exceeding 10 litres per hour for a single urinal bowl and 7.5 litres per hour for each 700mm of a slab urinal or two or more urinal bowls.

Urinals using flushing valves must not deliver a flush exceeding 1.5 litres per single flush per bowl each time the valve is operated.

In each case, the water supply must be protected by an air gap or some such no less effective mechanical device in accordance with fluid category 5.

**Refrigerators**

Many modern refrigerators contain ice making facilities that can be connected directly to a cold water supply. Where this is possible, the refrigerator connection should be installed in accordance with fluid category 2. The reason for this is that, although the water is fluid category 1, it undergoes both a change in temperature and state for it to become ice. Therefore, this kind of installation must be fitted with a single check valve or an approved EA/EB Backflow prevention device.

**Washing machines /Dishwashers**

Washing machines/Dishwashers are classified as fluid category 3 and must be protected against backflow. In most instances, an air gap to guard against backflow is already built into the appliance by the manufacturer. However, where multiple washing machines are installed on the same installation, then some form of mechanical backflow prevention is required. This is usually an approved type EC/ED backflow prevention device (or double check valve).

Modern washing and dishwashing machines only require a cold connection to the water supply. Internal heaters heat the water as required.

**Taps, outlets and valves**

**Mixer taps**
True mixer taps allow both hot and cold water to be mixed inside the tap body, and as such, constitute a cross connection between fluid category 1 and fluid category 2, which is not allowed under the Water Supply (water supply) Regulations 1999. Both hot and cold supplies must be protected by an approved EA/EB backflow prevention device (single check valve).

**Bi-flow mixer taps**

Bi-flow mixer taps are essentially two taps within a single tap body. The tap is divided through the body and into the spout so that the hot and cold water supplies do not mix until they emerge from the spout. They do not require backflow protection.

**Pillar taps**

These are available with both ½” and ¾” male BSP tails for use on washbasins and baths. They are designed to give and AUK2 airgap at the appliance, the outlet of the tap being higher than the spill-over level of the appliance.

**High Neck Pillar taps**

Similar in design to pillar taps, high neck pillar taps are designed for use on kitchen sinks. The high neck provides an AUK3 air gap suitable for fluid category 5, which is a mandatory requirement for kitchen/utility sinks, cleaners sinks, Belfast sinks and any sink or washbasin installed in a health care facility.

**Bib taps**
Bib taps are predominantly used in conjunction with Belfast sinks, cleaners sinks and situations where an AUK3 air gap is a requirement, such as hospitals, dental and doctors surgeries and health care facilities.

In most cases, they are fixed to the wall using back-plate elbows, although as can be seen in the photograph, they can also be installed with concealed pipework.

**Hose Union Bib taps (Outside taps)**

Similar in design to bib taps, hose union bib taps have threaded hose connection at the spout for easy connection of a garden hose. These must be regarded as a fluid category 3 risk and be protected by an approved type EC/ED backflow prevention device (or double check valve).

**Stop valves (BS5433 and BS1010)**

Stop valves are designed for the isolation of high/mains pressure cold water supplies. Internally, they are very restrictive to the flow of water, which makes them unsuitable for use on low pressure supplies.

Stop valves are available with compression and capillary connections for use on copper, polyethylene and polybutylene pipe.

Stop valves have an arrow moulded into the body of the valve to show the direction of the flow of water.

**Taps**

There are three categories of taps:

- Taps with rising spindles (BS1010)
- Taps with non-rising spindles (BS5412)
- Ceramic disc type
Taps with rising spindles (BS1010)

BS1010 taps contain a tap washer that is attached to a jumper plate. The jumper plate is then inserted into the rising spindle, which rises when the tap is rotated counter-clockwise, turning the tap on allowing water out of the tap spout.

Although BS1010 has been withdrawn for many years, BS1010 taps and head workings continue to be manufactured, because they are very reliable and can be repaired and refurbished easily and quickly.

BS1010 tap head workings are interchangeable, insomuch that tap head workings from one manufacturer will fit other taps.

Taps with non-rising spindles (BS5412)

BS5412 taps do not have a rising spindle. The spindle remains in one position, retained by a circlip. At the end of the spindle is a thread. When the tap is rotated counter-clockwise, the thread lifts a hexagonal-shaped barrel with a washer attached to it.

BS5412 taps are for use on washbasins, baths, kitchen sink and bidets, in ½” and ¾” sizes.

Unlike BS1010 taps, the head workings are not interchangeable from manufacturer to manufacturer, with each company having their own design.

Ceramic disc taps

Ceramic disc taps do not contain a washer. Instead they have two thin ceramic plates, one of which is fixed while the other rotates through 90°. Each plate has a pair of corresponding slots cut into them where the water passes through.

Ceramic discs tap heads correspond to the type of water. Hot tap heads rotate clockwise while cold rotate anti-clockwise. They are colour coded for easy identification red and blue.
Ceramic disc replacement needs to be carefully considered as the tap workings are not universal and the correct make and model of the tap must be available to be able to obtain the correct type of replacement.

*A typical ceramic disc head workings*

**Full-way gate valves**

Full-way gate valves are used predominantly to isolate low pressure water supplies from storage cisterns. They use a ‘gate’ to stop the flow of water without the need for a rubber washer. When the valve head is rotated counter-clockwise, the gate rises allowing water to flow.

The design of gate valves allows for water to flow at full bore with virtually no restriction in flowrate, hence the term ‘full-way’.

They are not suitable for high pressure water supplies.

**Spherical plug valves/ Servicing valves**

These isolation/servicing valves contain a brass ball or sphere with a hole through the middle. When the hole is in line with the pipe, the valve is on and water will flow. When the valve is turned through 90°, the hole is across the flow of water and the water flow stops.

There are many versions of spherical ball valves available. Some have handles or levers, such as the types shown in the photographs, while others have a screwdriver slot to enable the valve to be turned on and off.

**Drain valves (BS2878-2)**

Drain valves, also known as drain-off valve and M/T valves, are used to allow systems to be completely drained of water for repair, maintenance or replacement. They should be placed at low points in the system, close to places where the drained water will not pose a nuisance.
There are many types of drain valve available, including types with male threaded ends and those with or without packing glands.

Drain valves must be fitted in accordance with the Water Supply (water fittings) Regulations.

**Float operated valves (to BS1212 parts 1-4)**

Float Operated Valves or FoVs are used to control the flow of water into cisterns. Manufactured to BS1212, they are purposely designed to shut off the inflow of water once it has reached a predetermined level. They can be used on high pressure water or low pressure, depending on the type of orifice that the FoV is fitted with. A white orifice denotes high pressure supply (marked HP) and a red orifice denotes a low pressure supply (marked LP).

There are four specific types:

1. **B.S.1212 Part 1: Portsmouth pattern and Croydon types**
2. **B.S.1212 Part 2: Diaphragm type (brass)**
3. **B.S.1212 Part 3: Diaphragm type (plastic)**
4. **B.S.1212 Part 4: Torbeck equilibrium type (WC cisterns only)**

**B.S.1212 Part 1: Portsmouth pattern and Croydon types**

**Portsmouth pattern**

This type of FoV discharges water from underneath the valve. Because of this, they are prohibited from new installations without a back-flow prevention device as the outlet may become submerged in water if the valve fails, creating a possible back-flow contamination issue. However, they may be repaired if they are part of an existing installation.

The Portsmouth-type valve are vulnerable to noise and water hammer.

**Croydon pattern**

The Croydon-type FoV again discharges water from below the valve making it susceptible to back-flow issues. It is instantly recognisable due to the piston being in the vertical position. Croydon’s tend to be very noisy in operation. The Croydon valve is an obsolete design that is no longer manufactured but may still be found in older, high level WC cisterns.
B.S.1212 Part 2: Diaphragm type (brass) and B.S.1212 Part 3: Diaphragm type (plastic)

Parts 2 and 3 FoVs discharge water from the top of the valve rather than underneath, making them less likely to encounter backflow problems. The main difference with this kind of FoV is the size of the rubber washer. It is large, flat and very flexible.

The valve has very few moving parts, making it quieter in operation than the part 1 and less likely to be associated with water hammer and pipework reverberation.

Part 3 FoVs are almost identical to the part 2 except they are made of plastic making them ideal for WC cisterns but they are not recommended for storage cisterns in roof spaces due to the risk of freezing and splitting of the plastic body.

B.S.1212 Part 4: Diaphragm Equilibrium type (Torbeck)

Known as the Torbeck valve, it works on the principle that when the valve is in the open position, there is equal pressure on both sides of the rubber washer. When the required water level is reached, the float arm closes the pressure relief orifice on the front of the valve creating a higher pressure in front of the rubber washer. This pushes the washer on to water outlet to stop the flow of water.

These valves are much quieter than other FoV types although the valve tends to close with a ‘snap’ action, which can create some pipe reverberation.

These are only for use on WCs.
Water meters

External installations

There are two types of external water meter installation:

- A water meter fitted in an underground housing at the boundary of the property, and;
- The ‘Groundbreaker©’ external water meter housing fitted on an external wall of the property (as shown in the photograph)

Fitting a water meter externally has several advantages

1. It prevents illegal tampering with the water meter.
2. The meter can be read without the need to access the building

Internal installations

Water meters on existing cold water supplies are usually fitted internally close to the internal stop valve. It must be fitted in the manner shown in the image:

Stop Valve – Water Meter – Drain Valve – Stop Valve

This is to prevent a breech in the Water supply (water fittings) Regulations 1999 with regards to erroneous metering of water. Any water drawn through the drain valve on a live cold water supply would register on the meter as water consumed. If the drain valve was fitted below the meter, any water drawn off would not register.

Earth bonding should also be fitted from below the first stop valve to above the second stop valve so that earth protection is continued.
Showers

Gravity

Gravity showers use a mixing valve to blend cold water and hot water to the required temperature. There are several types:

- Manual-type mixing valves (non-thermostatic)
- Thermostatic mixing valves
- Bath/shower mixing taps

Manual-type mixing valves (non-thermostatic)

These do not have thermostatic control. They rely solely on the fact that both hot and cold supplies are being distributed at the same pressure and flowrate. Unlike thermostatic types, manual non-thermostatic valves do not adjust the water temperature or compensate for flow and temperature fluctuations. Because of this, it is important that the temperature of the hot water supply is fairly stable.

They are usually used on low-pressure water supplies, fed from a storage cistern.
Thermostatic shower valves

Thermostatic shower valves are fitted in exactly the same way as manual non-thermostatic mixing valves. The difference is that these shower valves maintain the showering temperature despite fluctuations in flowrates. The water temperatures generally are 15°C for cold water and 55°C for hot water will give a showering temperature of around 38°C to 42°C. There are two types of Thermostatic mixing valve:

- Wax Capsule – this uses a copper capsule containing a heat sensitive wax to control the water temperature. As the wax gets hot, it expands, which moves a shuttle controlling the flow of hot water. The hotter the water, the more expansion of wax takes place and the more the restriction is put on the flow of hot water.

- Bi-metallic coil – These use a coil of two different metals with differing expansion rates, usually brass and invar steel that are joined together. The brass expands more quickly than the steel and this causes the coil to distort. This distortion movement activates a shuttle the either increases or decreases the flow of hot water to the valve.

Pressure compensating mixing valves

These are designed to give greater temperature stability when the pressures and flowrates of the hot and cold supplies are different. Some types are designed for use on high/low pressure differences while others are designed for use on high/low flowrates where the pressures are equal. There are two specific types:

- Sequential control – these maintain temperature whilst adjusting to subtle
pressure fluctuations.

- Dual control – these have separate mechanisms to control temperature and flowrate. They react to differences in pressure but not to differences in temperature. Ideal for combi boilers and instantaneous gas water heaters.

Digital shower valves

These use a digital panel that communicates with the shower mixing valve to maintain a strict showering temperature regime. The digital control panel can be located as far as 10m away from the valve, giving greater installation flexibility.

Bath/shower mixing taps

Bath/shower mixing valves rely on equal pressures of both hot and cold supplies to work effectively. They simply replace the normal pillar-type bath taps, using the same tap hole spacing’s, which are generic to almost all bath types.

The example shown left is thermostatic.

To prevent back-siphonage, bath/shower mixers have an inbuilt air gap, known as a HC Diverter. This automatically drains the hose and shower head when the taps are turned off. Alternatively, single check valves (EA/EB Back flow prevention devices) can be fitted to both hot and cold supplies.

Shower pumps

Shower pumps are used to boost low pressure hot and cold supplies from storage cisterns, giving the ‘power shower’ feel. There are two different kinds:

- Single impeller outlet types, and;
- Twin impeller inlet types

Single impeller outlet shower pumps

A single impeller type shower pump is fitted AFTER the shower valve to boost the mixed water from the valve to the shower head.
A single impeller shower pump layout

A twin impeller shower pump layout

When water is heated, the air in the water starts to form around the walls of the pipe and the cylinder as little bubbles. By making the connection at 30 - 60° the air is allowed to pass through to the open vent pipe where it dissipates over the cistern. If the air was allowed to get into the shower pump, it would get trapped around the impeller, eventually leading to pump failure.

Hot connection for the shower taken at 90° to the angled cylinder connection

22mm pipe taken as far as possible before reducing to 15mm

An alternative connection direct to the cylinder using an essex flange

Connection for the cold feed to the cylinder is higher than the cold for the shower so that the hot water runs out first

A connection direct to the cylinder using an essex flange
Twin impeller inlet shower pumps

Twin impeller shower pumps are installed before the shower valve and boost the individual low pressure hot and cold supplies to the shower mixing valve. They have two identical impellers driven by a single motor to ensure that both the pressure and the flowrate to both supplies is the same.

Instantaneous electric showers

There are many different electric showers on the market with power ratings from 8kW to 12kW. Instantaneous electric showers are fed with water direct from the cold water mains supply. This is then heated by a small but powerful heater inside the shower itself.

Electric showers should be protected from back-siphonage by either an EC/ED backflow protection device (double check valve) or a hose retaining ring that is supplied with the shower. The retaining ring prevents the shower hose from entering bath or shower water.

Care should be taken when installing electric showers. The electrical installation must be completed by a qualified electrician so that the correct cable size, fuse and isolation switches are installed.

Water treatment

Water softeners

A water softener removes water hardness in hard water areas. They can be installed in both domestic and commercial buildings. It is usual practice to install water softeners as close to the main internal stop valve as possible so that the entire cold water installation is served with softened water.

Most water softeners use a process called ion exchange and are known as ‘base exchange water softeners’.
In this process the calcium and magnesium salts are replaced with sodium. Water softeners are designed to automatically wash away the calcium and magnesium ions with salt water at least once a day. Every month, the softener the unit requires the replacement of the salt granules.

Water softeners reduce the water hardness from around 350mg/l to less than 10mg/l.

It should be remembered that water softener installation requires that at least 1 tap, usually the kitchen sink, remain unsoftened for drinking and culinary purposes.

Water filters.

Water filters are designed to improve the taste and appearance of water by removing impurities. There are two common types:

- Jug filters that are filled from a tap
- Plumbed in filters usually sited under kitchen sinks.

There are generally, six different types of filter:

**Activated carbon**  Carbon in the form of powder, granules or block is used to remove chlorine, thereby improving the taste and odour of the water. The carbon has a large surface area and this attracts and absorbs organic substances in the water.

**Ion exchange**  Reduces lime scale formation and other metal-ion contaminants such as lead. They generally use granulated sodium salts to remove the mineral contaminant.

**Sediment filters**  These remove fine particles from the water by using a mesh through which the water passes. The finer the mesh, the more particles are removed.

**Reverse osmosis**  These work under high pressure by passing water through a semi-impermeable membrane. This process removes the impurities in the water.
Distillation

The mineral content is removed by boiling the water to steam and condensing the steam back to water.

Disinfection

These are usually used with water supplied from bore hole. They use ultra-violet light to kill bacteria and other micro-organisms.

Water conditioners

These work by suppressing lime scale formation. This has the following benefits:

- A reduction in the formation of scale in pipework
- Easier cleaning of outlets, such as shower heads
- Less lime scale formation on taps and outlets

There are three basic methods of conditioning water:

Electro-magnetic

These prevent scale build-up by influencing which type of calcium crystal form. By doing this, it ensures that only aragonite crystals are formed, which have a needle-like structure, making it difficult for them to adhere to smooth surfaces.

They are generally used on individual appliances, such as combination boilers, to reduce internal scale build-up in hard water areas.

An electrolytic water conditioner

Electrolytic

These add a microscopic amount of zinc to the water, which prevents the formation of calcium crystals. Any crystals that form are washed away by the water flow.

An electrolytic water conditioner
Electro-chemical

These conditioners are quite large and require an electrical supply. They are filled with ceramic beads and work by causing the magnesium and calcium crystals to precipitate, or re-form.

Cisterns

A cistern is defined as a vessel containing water at atmospheric pressure. In plumbing, there are several different types:

Cold water storage cisterns (CWSC)

These store water for distribution in a low-pressure indirect cold water system. It supplies cold water only.

Cold water feed cisterns (CWFC)

Identical to cold water storage cisterns. The difference is that cold feed cisterns are designed to feed cold water, via the cold feed pipe, to an open vent hot water storage system.

Combined Cold water storage and feed cisterns (CWS&FC)

These are a combination of the first two cisterns and are primarily for use when the cistern is supplying cold water to both a cold water system and hot water system from the same cistern.

Feed and expansion cisterns (F&E)

These small cisterns that are designed for use with vented hot water heating systems and, as the name suggests, combine two very important roles:

1. It supplies cold feed water to a heating system, and;
2. Accommodates any expansion of the water due to the water being heated.

The cistern must be large enough accommodate any expanded water and must be sized accordingly.

WC/urinal flushing cisterns

These are installed with the sole purpose of clearing the contents of WC pans and Urinal bowls. Urinal cisterns are usually automatically flushed at set periods and should be fitted with a water saving device such as a cistermiser © valve. Urinals can be fitted with flushing valves that flush directly from the mains cold water. WCs must be flushed using a cistern fed flush arrangement using either a siphon or a dual flush valve (4 ltrs short flush, 6 ltrs long flush). They are covered in greater detail in a later chapter.
AC2.8 State the system layout features for protected plastic storage cisterns

General installation requirements for domestic cisterns

Schedule 2 paragraph 16 of the Water Supply (water fittings) Regulations 1999 states that a cistern supplying low pressure cold water to either a cold water or hot water system should be capable of supplying wholesome, **potable** water. Protection measures must be included during installation to ensure that the water cannot become contaminated in any way. Cisterns, therefore, must include:

a) An effective inlet control device to maintain the correct water level i.e. a float operated valve.

b) Service valves on inlet and outlet pipework connections to allow for maintenance and repair activities.

c) Screened warning/overflow pipes.

d) A rigid, close fitting lid, which is not air tight but excludes light and insects.

e) Insulation against freezing or undue warming.

f) Installation methods that eliminate the risk of contamination.

g) Arranged so that water can circulate preventing stagnation.

h) Support to avoid distortion or damage which could lead to leaks

i) Access for maintenance and cleaning.

A cistern complying with Schedule 2 para 16 of the Water Supply (water fittings) Regulations 1999
Installation requirements for domestic cisterns

Cisterns that are installed in roof spaces and filled with water create stress on the roof timbers and joists. Water is heavy. At 4°C, 1 litre of water = 1kg. When this is multiplied by the average cistern water capacity of say 230 litres, it has the mass of almost \( \frac{1}{4} \) of a metric tonne. Good practice dictates that, wherever possible, cisterns should be positioned over a load bearing, supporting wall, as shown left.

Many modern properties do not have internal supporting walls and if this is the case then a suitable platform (often called a stillage) must be constructed to spread the load across the roof trusses. The platform should be covered in marine grade plywood or tongued and grooved boarding at least 21mm thickness. The platform should be at least 50mm larger than the base area of the cisterns on all sides.

Clearance for access and maintenance of cisterns

The minimum access requirement for cisterns of less than 1000 litres for cleaning, maintenance and inspection is 350mm. This allows the repair and replacement of float operated valves.

Inlet requirements for domestic cisterns

The Water Supply (water fittings) Regulations 1999 state that a cistern should be fitted with an adjustable float operated valve (FOV) or other no less effective device for controlling the flow of water into the cistern.
For domestic cisterns, this is a BS1212 FOV conforming to BS1212 Part 1 (fitted with suitable backflow protection) and BS1212 part 2 as these allow the adjustment of the water level within the cistern. BS1212 covers FOVs up to 54mm diameter. FOVs that exceed this size must be authorised by the local water undertaker.

Outlet requirements for domestic cisterns

The drawing left indicates the position of the outlets (cold feed pipe, cold distribution pipe) for domestic cisterns. The cold distribution pipe must be the lowest connection on the cistern to ensure that water to the hot water storage vessel (cylinder) via the cold feed pipe is the first to cease flow in the event of mains cold water failure. This prevents possible scalding when showers and mixing valves are used. The cold distribution pipe should be taken from the bottom of the cistern to prevent sediment build up and possible legionella growth. An alternative position for the cold distribution pipe (25mm below the cold feed pipe and on the opposite side of the cistern) is shown in the drawing.

Correctly positioned cistern pipework connections helps to prevent water stagnation by ensuring that water circulation takes place within the cistern when the outlets are used. If there is only one outlet connection, such as a cold feed to a hot water storage vessel, then this MUST be fitted on the opposite side to the FOV.
If two outlets are fitted, then the highest outlet, usually the cold feed to the hot water system, should be fitted on the opposite side to the inlet connection (FOV).

**AC2.9 State the methods of linking cold water storage cisterns for use in dwellings**

Providing large quantities of water can be problematic where there are space restrictions such as in roof spaces. In these circumstances, cisterns will need to be linked. However, there are four points that must be remembered if stagnation and possible legionella bacteria growth are to be avoided:

1. The cistern capacities must be small enough to encourage rapid turnover of water but large enough to prevent water running out.
2. The cisterns must have Inlet and outlet connections at opposite ends.
3. They should be regularly inspected and cleaned to prevent sediment build-up.
4. Cisterns should be dressed and installed in accordance with the Water Supply (water fittings) Regulations.

Cisterns can either be interconnected in two ways:

- In series
- In parallel

**Cisterns connected in series**

Take a look at the drawing left. This shows how cisterns should be connected in series. Here, the cisterns are connected at the ends in two places – the bottom of the cistern and the middle of the cistern. This allows water movement across the whole body of water and not just at the bottom. The primary connection i.e. the connection that gets the most usage usually the cold feed to the hot water storage vessel, should be connected on the opposite cistern to where the FOV is fitted, this encourages water movement and prevents stagnation of water. The secondary connection i.e. the cold distribution pipework, can be made on the cistern with the FOV if required. The overflow/warning pipe must be connected onto the cistern with the FOV.

Most importantly, both cisterns MUST be of the same size and capacity and no more than two cisterns should be connected in series.
Cisterns connected in parallel

The drawing left shows four cisterns connected in parallel. In other words, they are connected end-on. This method is usually used where two or more cisterns are to be interconnected. With this method, every cistern has an FOV and a service valve and, since where a FOV is fitted, there should be an overflow, every cistern is fitted with its own independent overflow to outside the property. Overflows must not be connected together and must be placed in a visible and conspicuous position.

The cisterns must be arranged so that:

a. All of the cisterns are connected in the middle and at the bottom to allow good flow-through of water.

b. Cistern capacities should be kept to a minimum to ensure a frequent and rapid turn-over of water to prevent stagnation.

c. Inlets and outlets are kept on opposite ends/sides of the cistern.

d. All cisterns should have independent gate valves on each outlet pipe.

e. Two cisterns can be isolated at any time for cleaning and maintenance. While two cisterns are out of commission, two cisterns will be working. This allows the cold water to remain in operation at all times.

f. By using delayed action float operated valves, stratification of the water is prevented.

The materials used for fabricating domestic cisterns

For domestic properties, cisterns are usually manufactured from two types of plastic:

- Polyethylene
- Polypropylene

These two materials are chosen because they have a light weight construction, strength, good resistance to bacterial growth and corrosion and have the flexibility to be able to be passed through roof space openings. Cisterns must be properly supported over their entire base area.
Holes to allow the fitting of tank connectors must be cut using a hole saw. A 17mm hole saw will allow a \( \frac{3}{8} \)" x 15mm tank connector to be fitted and a 25mm hole saw will suffice for a \( \frac{3}{4} \)" x 22mm tank connector. The following points should be noted when dressing a cistern:

- Heated pipework must not be used to make holes in plastic cisterns as this alters the structure of the plastic making it brittle and susceptible to cracking and leakage.
- No jointing linseed oil-type compound must be used when making connections to plastic cisterns as these tend to break down the plastic making it susceptible to cracking. The linseed oil base also provides a breeding culture for legionella pneumophila bacteria.
- Joints to the cistern can be made with plastic ‘poly’ washers.
- Do not overtighten the tank connectors as this may cause the cistern to split.

Warning and overflow pipes

Cisterns up to 1000 litres are fitted with overflow pipes, while cisterns 1000 litres+ are fitted with warning and overflow pipes:

- A warning pipe is a small overflow pipe that is intended to act as an early warning sign that the FOV has malfunctioned and that the overflow is about to start running. This is important because overflow pipes are generally one size larger than the inlet water pipe and FOV and, once they begin to run, they can very quickly waste vast amounts of water. Warning pipes are not required on cisterns of less than 1000 litres capacity.
- An overflow pipe, sited below the shut off level of the FOV, acts as a sign that the FOV has failed to shut off. It has two vital jobs:
  - To show that a FOV has malfunctioned and requires repair.
  - To divert water away from the building that would otherwise leak into the property and cause water damage due to FOV malfunction.

Overflow pipes should be sized correctly so that in the event of total FOV failure and the water running at full bore into the cistern, the FOV can never become submerged in water as this could lead to a backflow situation and possible cold water contamination.
Domestic cisterns of less than 1000 litres capacity

Where domestic cisterns are concerned, it is general practice to make the overflow one size larger than the water inlet, so if a 15mm FOV is installed, the overflow would be 22mm etc. The overflow should have a continuous fall along its entire length and should terminate outside the dwelling in a visible and conspicuous position e.g. over an outside door. It should contain a mesh or screen to prevent the ingress of vermin and insects and should contain a dip pipe to prevent freezing air blowing across the surface of the water. The overflow should be positioned so that it is 25mm below the FOV and 25mm above the shut-off water level.

Cistern Capacities

The capacities of cold water cisterns will depend upon the system the cistern is supplying. As such, BSEN806 and BS8558 do not state a minimum or maximum capacity. These documents recommend that cold water storage requirements are calculated. Calculations are based upon:

a) The size of the dwelling
b) The number of outlets served
c) The number of occupants.
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Learning Outcome 3

Know the site preparation techniques for cold water systems and components
There are five Assessment criteria in Learning Outcome 3:

**AC3.1.** Identify the sources of information required when undertaking work on cold water systems

**AC3.2.** Identify the preparatory work required to be undertaken to the building fabric in order to install, decommission or maintain cold water systems and components.

**AC3.3.** Identify the protection measures required to the building fabric or customer property, during and on completion of work on cold water systems and components.

**AC3.4.** Identify the pipework materials and fittings required to complete work on cold water systems

**AC3.5.** State the range of hand and power tools required to complete work on cold water systems and components.

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### AC3.1 Identify the sources of information required when undertaking work on cold water systems

#### Ensuring water quality in the property

Under provisions laid down by the Water Industry Act 1991 and then later the Water Act 2003, the UK government introduced two pieces of legislation that regulate how plumbing systems are installed and maintained in domestic buildings in the UK. These are:

- The Water Supply (water fittings) Regulations 1999; and,
- The Private Water Supply Regulations 2016

#### Water supplied by a Water Undertaker

The supply of wholesome water to the majority of consumers is the responsibility of the UK water authorities. They are known as Water Undertaker’s. It is their responsibility to collect, clean, distribute and maintain the water supply in such a manner that the water is fit for human consumption under section 67 of the Water Industry Act 1991. Their responsibility ends at the external (boundary) stop tap to the property. From here, the responsibility rests with the owner of the property or the plumber.

#### The Water Supply (water fittings) Regulations 1999

Prior to 1999, each Water Undertaker had their own rules and bylaws based around the 1986 101 model water bylaws issued by the UK government. This created problems because each authority had local variations with no common standard. On July 1st 1999, the government issued the Water Supply (Water Fittings) Regulations 1999 that standardised working practices across all areas of the United Kingdom. These were initially linked to BS6700 and then later to BSEN806: Specification for installations inside buildings conveying water for human consumption: PARTS 1 to 5 and BS 8558:2015: Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.
Complementary guidance to BS EN 806.

The Water Supply (water fittings) Regulations were written under section 74 of the Water Industry Act 1991 to ensure that the systems of plumbing installed in properties prevent the following:

- Contamination of water
- Wastage of water
- Misuse of water
- Undue consumption of water
- Erroneous metering of water

It should be remembered that these regulations only apply to water that has been supplied by a Water Undertaker and do not apply to water supplied from a private source.

A free copy of the regulations can be downloaded from www.opsi.gov.uk/si/si1999/19991148.htm.

Private water supplies

Private water supplies are water supplies that are not supplied by the Water Undertaker and, as such, are solely the responsibility of the owner and user of the water supply. This could be a single dwelling or multiple properties supplied from the same source. Private water may be supplied from a borehole, stream, river, spring or well.

The quality of the water supplied from private sources can be variable. Some sources offer good quality water where little treatment is necessary but others present a risk to health due to the water quality and require careful monitoring.

The responsibility for regulating private water supplies rests with the local authority but it is also vital that owners are aware of the potential risks. Owners should:

- Ensure that the source is protected against contamination from grazing animals and any contamination that may come from upstream.
- Install and maintain sufficient equipment that will maintain a satisfactory water quality.
- Ensure that the water is adequately disinfected before use.
- Ensure that any stored water is stored in such a way as to prevent contamination after storage but before use.
- Ensure that the water quality is tested regularly.

The Private Water Supply Regulations 2016

These ensure that water supplied from a private source are safe for people to drink. Changes from the 2009 Private Water Supply Regulations now classify private water supplies into four categories:

- Large supplies serving commercial and public buildings such as hotels, restaurants, nursing homes, bed and breakfast establishments, village halls and large domestic users using more than 10m³/day or supplying more than 50 people per day on average.
- Small supplies serving two or more domestic properties but with no commercial usage, using less than 10m$^3$/day or fewer than 50 people per day on average.
- Single property supplies where water is supplied for domestic purposes only.
- Private distribution networks. The scope of the regulations now includes networks where the water is distributed further beyond the responsibility of the licenced water company. These include such properties as caravan parks, industrial estates or country estates or where water is distributed by tanker.

The Role of local authorities in regulating private water supplies

The local authority acts as the regulator for the private water supplies in their area and have statutory duties under the PWSR. Local Authorities must:

- Conduct a risk assessment on every property with private water supply in their area.
- Undertake monitoring in order to determine compliance with water standards.
- Provide monitoring data to the Drinking Water Inspectorate (DWI).

The local authority has enforcement powers to ensure that a water supply is improved, should it fall below the minimum cleanliness requirement, by the relevant person(s) who control that supply.

The Role of Drinking Water Inspectorate (DWI) in regulating private water supplies

The DWI plays a statutory role in acting as technical advisors to Local Authorities in relation to the implementation of the Private Water Supplies Regulations 2016. This includes technical and scientific assistance on all aspects of drinking water quality on both public and private supplies.

The Water Supply (water quality) Regulations 2016

In the United Kingdom, all water, whether from a private source or supplied by a water undertaker, must comply with the EU Drinking Water Directive 98/83/EC. It is the duty of every member state to implement rules that reflect the directive, which must meet the minimum European Legislation. This legislation reflects the recommendations of the World Health Organisation (WHO).

The law requires that all drinking water is wholesome and clean. It sets down minimum acceptable concentrations of potential contaminants. It states that:

"Water is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health."

More information can be found at [http://www.water.org.uk/](http://www.water.org.uk/)


In 2010 the Building Regulations were updated and amended. Approved Document G - Sanitation, hot water...
safety and water efficiency was extended to bring new areas under the control of the Building Regulations, most notably, the installation of systems and water efficiency.

The amended Regulation Document G is broken down into 7 parts:

**G1 – Cold Water Supply**

Requirements on supply of wholesome water for drinking, washing or food preparation. G1 also deals with the provision of water of a suitable quality to sanitary appliances fitted with a flushing device.

**G2 – Water Efficiency**

G2 and Regulations 17K and 20E of the Building Regulations 2000 set out new requirements on water efficiency in NEW dwellings.

**G3 – Hot Water Supply and Systems**

Enhanced and amended provisions on hot water supply and safety, applying safety provisions to all types of hot water systems and a new provision on scalding prevention.

**G4 – Sanitary Conveniences and Washing Facilities**

Requirements for sanitary conveniences and hand washing facilities.

**G5 – Bathrooms**

Requirements for bathrooms, which apply to dwellings and to buildings containing one or more rooms for residential purposes.

**G6 – Kitchens and Food Preparation Areas**

New provision requiring sinks to be provided in areas where food is prepared.

**Water efficiency Calculator for new dwellings**

Sets out the methodology required to allow the calculation of water consumption in dwellings, limiting water use to 125 litres (optional 110 litres) per person per day

**Water efficiency Calculator for new dwellings**

The requirement under G2 of the Building Regulations states that:

> **G2. Reasonable provision must be made by the installation of fittings and fixed appliances that use water efficiently for the prevention of undue consumption of water.**

**Water efficiency of new dwellings** (Regulation 17K)

36. (1) The potential consumption of wholesome water by persons occupying a new dwelling must not exceed the requirement in paragraph (2).

(2) The requirement referred to in paragraph (1) is either—

a) 125 litres per person per day; or

b) in a case to which paragraph (3) applies, the optional requirement of 110 litres per person per day, as measured in either case in accordance with a methodology approved by the
Secretary of State.

**Wholesome water consumption calculation** (Regulation 20E)

37.—(1) Where regulation 36 applies, the person carrying out the work must give the local authority a notice which specifies—

a) which of the requirements in regulation 36(2)(a) or (b) applies to the dwelling; and

b) the potential consumption of wholesome water per person per day in relation to the completed dwelling.

Requirement G2 applies only when a dwelling is—

a) erected; or

b) formed by a material change of use of a building

### The methodology of the Water efficiency Calculator

The water efficiency calculator uses the water consumption figures that are provided from manufacturers data. These must be obtained before the assessment can be attempted. The figures are then entered into a series of tables to determine the water consumption per person. Water consumption/flowrate figures are required for:

- WCs
- Taps
- Baths
- Dishwashers
- Washing machines
- Showers
- Water softeners
- External taps.

Bidets are exempt from the calculation due to their minimal water consumption.
### Example of the Water efficiency calculator

<table>
<thead>
<tr>
<th>Installation type</th>
<th>Unit of measure</th>
<th>(1) Capacity/flow rate</th>
<th>(2) Use factor</th>
<th>(3) Fixed use (litres/person/day)</th>
<th>(4) Litres/person/day = [(1) x (2)] + (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC (single flush)</td>
<td>Flush volume (litres)</td>
<td>4.42</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC (dual flush)</td>
<td>Full flush volume (litres)</td>
<td>1.46</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Part flush volume (litres)</td>
<td>2.96</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WCs (multiple fittings)</td>
<td>Average effective flushing volume (litres)</td>
<td>4.42</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taps (excluding kitchen/utility room taps)</td>
<td>Flow rate (litres/minute)</td>
<td>1.58</td>
<td>1.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bath (where shower also present)</td>
<td>Capacity to overflow (litres)</td>
<td>0.11</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shower (where bath also present)</td>
<td>Flow rate (litres/minute)</td>
<td>4.37</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bath only</td>
<td>Capacity to overflow (litres)</td>
<td>0.50</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shower only</td>
<td>Flow rate (litres/minute)</td>
<td>5.60</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen/utility room sink taps</td>
<td>Flow rate (litres/minute)</td>
<td>0.44</td>
<td>10.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing machine</td>
<td>Litres/kg dry load</td>
<td>2.1</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dishwasher</td>
<td>Litres/place setting</td>
<td>3.6</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water softener</td>
<td>Litres/person/day</td>
<td>1.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(5) Total calculated use = (Sum column 4)

(6) Contribution from greywater (litres/person/day) from Table 4.6 Appendix A, App Doc G

(7) Contribution from rainwater (litres/person/day) from Table 5.5 Appendix A, App Doc G

(8) Normalisation factor

(9) Total water consumption = [(5) – (6) – (7)] = (8)

(10) External water use

(11) Total water consumption = (9) + (10) (litres/person/day)

---

**British Standards BSEN806:2012 Pts 1 to 5**

BSEN806: Specifications for installations inside buildings conveying water for human consumption

- **BSEN806 – 1: 2000. General.** This document specifies potable water installation requirements and gives recommendations on the following aspects of hot and cold water installations:
  - Design
  - Installation
  - Alteration

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Author: BPEC Ltd. Editor: BPEC Ltd. Design: BPEC Ltd
Testing
- Maintenance and operation.
- Part 1 of BSEN806 also covers the pipework installation from the point of entry when the property is supplied with water from a private water source.

- **BSEN806 – 2: 2005. Design.** This document provides technical information so that the following points may be achieved from the design and installation:
  - Appropriate pressures and flowrates
  - Water quality at the tap is not contaminated or affected by the location or environment
  - The system avoids wastage of water and leakage.
  - The system is efficient, convenient, reliable and safe.
  - The system has a reasonable working life span.

- **BSEN806 – 3: 2006. Pipe sizing. Simplified method.** This document describes the simplified method for pipesizing drinking water standard installations as defined in section 4.2. However, the document does not engage in pipesizing for domestic firefighting systems.

- **BS EN 806 – 4:2010. Installation.** Specifies the requirements of water installations within buildings and gives recommendations for their correct installation. It also covers pipework outside buildings but within the premises as outlined in BSEN806 – 1:2000. It applies to new, altered and repaired installations.

- **BS EN 806 – 5:2012. Operation and maintenance.** This document takes the form of a practice specification. It specifies the requirements for the correct operation and maintenance of potable water supply installations within buildings and for pipework outside building but within premises in accordance with BSEN806 – 1:2000.

BSEN806 Parts 1 to 5 completely supersede BS6700 in all aspects of hot and cold water supply. **BS 8558: 2015 Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages** - complementary guidance to BS EN 806, now becomes the lead document for potable water supply in premises.

BS 8558: 2015 Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages - complementary guidance to BS EN 806

BS8558 was developed primarily to provide complimentary guidance to BSEN806 Pts 1 to 5. Together, this complete suite of British Standards provides recommendations into best practice for the design, installation, testing, operation, maintenance and alteration of hot and cold water systems for domestic buildings.

BS8558 bridges the gap between BSEN806 and its predecessor BS6700 and provides UK guidelines for, not just plumbers, but the water supply industry as a whole.
PD 855468:2015 Guide to the flushing and disinfection of services supplying water for domestic use within buildings and their curtilages

Flushing and disinfection of systems used to be part of BS8558:2011. However, the latest version of BS8558:2015 excludes flushing and disinfection. Instead, flushing and disinfection of systems is now a separate document PD 855468:2015.

PD 855468:2015 provides guidance on the cleaning, flushing and disinfection of cold water systems to control microbiological growth and the removal of debris. This includes guidance on:

- Deployment of the correct tools and personnel
- The use of the correct disinfectants
- How to respond if a microbiological problem is identified
- Keeping records of cleaning and disinfection

This new document applies to systems supplying water to domestic purposes within buildings and their curtilages, and includes water used in food preparation.

Manufacturer technical instructions

The manufacturer’s instructions are probably the most important document to read and consult when installing, servicing and maintaining appliances, components and equipment, because they instruct us on the best methods to use whilst keeping to current legislation and regulations. In some cases, it may appear that these instructions contradict the regulations. This occurs because regulations and codes of practice are only updated periodically, whereas manufacturers are constantly reviewing and updating their literature in line with modifications and current good practice. Where a conflict exists, manufacturer’s literature should always be followed. If not:

- The warranty of the equipment may be void.
- Regulations may be inadvertently broken
- The installation may be dangerous.

AC3.2 Identify the preparatory work required to be undertaken to the building fabric in order to install, decommission or maintain cold water systems and components

This topic was covered in Unit D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems, Learning Outcome 3, AC3.1: Define the typical range of activities to be carried out when working on plumbing and heating systems and AC3.8: State the work methods for preparing building construction features for installation work.
AC3.3 Identify the protection measures required to the building fabric or customer property, during and on completion of work on cold water systems and components

This topic was covered in Unit D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems, Learning Outcome 3, AC3.4: Identify how to protect the building fabric or customer property before the work commences.

AC3.4 Identify the pipework materials and fittings required to complete work on cold water systems

This topic was covered in Unit D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems, Learning Outcome 2, in the following Assessment Criteria:

- **AC2.1.** Identify pipe work materials used in domestic plumbing and heating work
- **AC2.2.** State the range of typical pipe material sizes available for use in dwellings.
- **AC2.3.** State the acceptable methods of jointing new hot and cold water pipe to existing lead pipe work.
- **AC2.4.** Identify the general fitting types used in dwellings.

AC3.5 State the range of hand and power tools required to complete work on cold water systems and components

This topic was covered in Unit D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems, Learning Outcome 1, in the following Assessment Criteria:

- **AC1.1.** State the purpose of hand and power tools used to carry out work on plumbing and heating systems.
- **AC1.2.** Identify the different types of hand and power tools used to carry out work on plumbing and heating systems.
Learning Outcome 5

Know the installation requirements of cold water systems and components
There are Ten Assessment Criteria in Learning Outcome 5:

- **AC5.1.** State how to take readings of the incoming water supply pressure and flow rate.
- **AC5.2.** Identify suitable methods of connecting cold water system supply pipework to incoming service pipework.
- **AC5.3.** State the positioning requirements of components in cold water systems.
- **AC5.4.** Identify how to measure, mark out and drill plastic storage cisterns to receive pipework connections.
- **AC5.5.** Identify how to make pipework connections to storage cisterns.
- **AC5.6.** State the positioning and fixing requirements for cold water system pipework and components.
- **AC5.7.** State how to select clips and brackets appropriate to the cold water system pipework and the industry recommended spacings.
- **AC5.8.** Identify how to position, fix and connect new cold water pipework to outlets.
- **AC5.9.** Identify suitable methods of making new pipe work connections into existing cold water system pipework.
- **AC5.10.** Identify the insulation requirements of cold water system components.

**AC5.1 State how to take readings of the incoming water supply pressure and flow rate**

With modern appliances and hot water systems, it may be necessary to check the water pressure and flow rate of the system first before you install them. This is to ensure that the water supply is adequate and that, once installed, the appliance will conform to the manufacturers performance data.

Taking water pressure and flow rate is easy providing you have the correct equipment. A pressure and flow rate kit, like the one shown in the photograph, is easily attached to existing taps inside or outside the dwelling and gives accurate readings of both static and dynamic pressures and system flow rate.

For a true reading of the pressure and flow rate, the gauge needs to be used on the tap that is nearest to the incoming supply stop valve.

A pressure gauge can be used to take accurate pressure readings from existing taps. These simply attach to taps using a rubber hose-type fitting. A chain wrapped over the tap keeps the gauge in place while the reading is being taken.
Flow rate can be taken using a weir cup. However, often the flow rate is too much to get an accurate reading with a weir cup, so caution must be exercised.

**Other ways of taking flow rate readings**

A very simple method of taking flow rate requires the use of a pyrex measuring jug:

1. Turn the tap on full
2. Using a stopwatch (there’s usually one on every mobile phone), place the jug under the running water and time it for 6 seconds.
3. After 6 seconds, remove the jug and check the water content of the jug.
4. Multiply the amount of water by 10. This will give the flow rate in minutes. For example:

700 millilitres was registered after 6 seconds, so:

\[
700 \text{ml} \times 0.7 \times 10 = 7 \text{litres/min}
\]

if the flow rate is required in l/s, then simply divide the answer by 60:

\[
7 \div 60 = 0.116 \text{ l/s}
\]

Less than 10 litres per minute is considered to be low flow rate. 10 to 15 l/m is acceptable and anything over 15l/m is considered to be good.

**AC5.2 Identify suitable methods of connecting cold water system pipework to incoming service pipework**

**Fittings for Medium Density Polyethylene**

**incoming cold water main**

**The Philmac Universal Transition Coupling**

This fitting is designed to connect many different types of pipe together using a common fitting body and a selection of different inserts to accommodate the different types of pipe available. Push fit versions are also available.

**Brass Compression fittings**

These are specifically made to fit the diameters of MDPE pipe. The method of installation is the same as the compression fittings mentioned earlier but with one
exception. The pipe requires a copper or nylon insert to be placed inside the pipe to strengthen the pipe wall. Because these are used on underground water supplies, they are made from corrosion resistant brass or gunmetal.

Fittings for Copper incoming cold water main

Type B Manipulative Compression fittings

These fittings are called manipulative because the end of the copper tube must be worked or manipulated before a joint can be made. The end of the copper must be flared out with a swaging tool. The fitting is comprised of the fitting body, the compression nut, a compensating ring and an adapter to allow the copper to make a leak free joint with the copper tube.

Generally, these fittings are used on R220 grade soft copper tubes for underground water service pipes.

Capillary fittings

There are two types of capillary fitting. Those that contain solder, called ‘solder ring’ fittings and those where the solder has to be applied during the jointing process, called ‘end feed.’ These were discussed earlier in Unit D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems, LO2, AC2.5.

Lead

Leadlocks are the most common fitting used to convert lead pipe to copper/polybutylene pipe. Connection is made via a rubber ‘O’ ring being compressed against the lead pipe. These were discussed in Unit D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems, LO2, AC2.2.
AC5.3 State the positioning requirements of components in cold water systems

Supply stop valves
Stop valves must be located as near to the point where the water supply enters the building as possible. They must be easily accessible for isolation during repairs and maintenance and should be kept in good working order. A drain valve must be installed immediately above the supply stop valve.

Drain valves
Drain valves must be fitted at low points in hot and cold water installations to facilitate complete draining of the water to prevent stagnation and contamination. They must not be located in positions where they could become submerged in water and must not be fitted below ground.

Water meters
Water meters must be installed before any draw-offs, appliances or equipment so that the whole of the installation is metered. They should, if possible, be located above ground with easy access. It is possible to install them below ground in special meter housings. They must be located as near to the point where the water supply enters the building as possible.

Water conditioning devices
Water softeners should be installed as close to the cold water rising main as possible but it should be remembered that drinking water points and/or an outside tap should be installed before the water softener connection.

Service valves
The Water Regulations state that a service valve should be fitted as close to every float operated valve as is practicable. It is not a requirement to install service valves at every tap or appliance. However, installing service valves to isolate appliances and zones is considered good practice.

Backflow prevention devices
Backflow prevention devices are positioned according to the risk of contamination to the mains water supply. There are two methods:

- **Point of use protection** – where the backflow prevention device is installed close to the appliance or outlet, such as an outside tap or electric shower, or;

- **Zone protection** – where the back flow prevention device is installed close to the branch of a zone or area to protect the water supply from that zone or area.
AC5.4 Identify how to measure, mark out and drill plastic storage cisterns to receive pipework connections

Marking and drilling cold water cisterns is a fairly simple task. The following points should be remembered:

- The FOV should be positioned 50mm down from the spill over level (top) of the cistern. It should be positioned to give easy access to the FOV.
- The overflow should be positioned on the opposite side to the FOV and 25mm down from the FOV centre line.
- The position of the hot and cold distribution connections should be considered carefully. The connection that has the most use i.e. the hot water cold feed connection, should be position on the opposite side to the FOV. This is to encourage water movement and prevent stagnation.
- If there is to be only one distribution connection, this should be positioned on the opposite side to the FOV, 25mm up from the base of the cistern.
- If there are to be two connections – a cold distribution connection and a hot water cold feed connection – the hot water cold feed connection must be 25mm higher than the cold distribution connection. This is to ensure that, in the event of mains cold water failure, the hot water supply runs out first. This is a safety feature to prevent scalding.
- If a hot water vent is to be placed inside the cistern, the vent must be positioned so that it does not interfere with the operation of the FOV.

Once the cistern has been marked (with a pencil), the correct size holes can be drilled with a hole saw. Spade
bits should not be used as these tend to split the cistern. NEVER use the heated end of a piece of copper tube to burn the holes through as this alters the molecular structure of the plastic cistern and encourages the cistern wall to crack around the holes, causing leaks.

Once the holes have been drilled, the cistern should be cleaned inside to remove any debris left by the hole saws. The debris can work its way through the system causing problems with taps and valves.

AC5.5 Identify how to make pipework connections to storage cisterns

Connections to cisterns are made using tank connectors, such as the one shown in the photograph below. The joint should be made only using plastic washers, known as poly-washers of the correct size placed outside and inside the cistern. Jointing compounds and pastes, especially those containing linseed oils, must not be used as these can alter the molecular structure of the plastic cistern. PTFE tape can be used if required.

Once the tap connector has been placed into position, do not overtighten it as this can cause the cistern to split. If using capillary-type tank connectors, DO NOT solder the fitting in position as this will melt that cistern.

AC5.6 State the positioning and fixing requirements for cold water system pipework and components

Pipework installed under suspended timber floors, in solid floors and embedded in walls

The Water Supply (water fittings) Regulations 1999, Schedule 2, Regulation 7 states that:

7 – (1) No water fitting shall be embedded in any wall or solid floor.

(2) No fitting which is designed to be operated or maintained, whether manually or electronically, or which consists of a joint, shall be a concealed water fitting.

(3) Any concealed water fitting or mechanical backflow prevention device, not being a terminal fitting, shall be made of gunmetal, or another material resistant to dezincification.

(4) Any water fitting laid below ground level shall have a depth of cover sufficient to prevent water freezing in the fitting.

(5) In this paragraph ‘concealed water fitting’ means a water fitting which –
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a)  is installed below ground;
b)  passes through or under any wall, footing or foundation;
c)  is enclosed in any chase or duct; or
d)  is in any other position which is inaccessible or renders access difficult.

Obviously, when we install plumbing pipework in dwellings, there are occasions when we have to place pipes under timber floors and in studded timber walls. It is simply not possible to install all of the pipework on the surface. The Regulations allow the installation of pipes in walls and under floors provided that we follow the guidance given in the WRAS Water Regulations Guide.

Guidance note G7.1 States that:

Unless they are located in an internal wall which is not a solid wall, a chase or a duct which may readily be exposed or under a suspended floor which may, if necessary be readily removed and replaced or to which there is access, water fittings should not be:

a)  located in the cavity of a cavity wall
b)  embedded in any wall or solid floor
c)  installed below a suspended or solid floor at ground level.

The drawings below illustrate what this statement means:

**Pipes laid under floors**

**Pipe in a purpose made duct with a removable cover in a solid floor**

The enclosure within pipe ducts is acceptable providing that leaks would become apparent and the section of pipe can be exposed by the removal of superficial surface finishes such as tiles or screed.

**Pipe in a purpose made duct with no access**

This method is only acceptable when there are few joints that are enclosed in the duct and the pipe can be withdrawn for inspection.
Pipe in an insulated ground floor

Acceptable without the need for thermal insulation. Regular clipping to the British Standards is required.

Pipe located under a non-insulated ground floor

Access must be at intervals of not more than 2m and must be at every joint so that the whole length of pipe may be inspected.

Pipes positioned in walls

Pipe in a purpose made duct with a removable cover in an insulated cavity wall

The enclosure within pipe ducts is acceptable providing that leaks would become apparent and the section of pipe can be exposed by the removal of superficial surface finishes such as tiles or plaster. Frost protection may be required.

Pipe in a purpose made duct with a non-removable cover in an insulated cavity wall

This method is only acceptable when there are no joints that are enclosed in the duct. Frost protection may be required.
Pipe in a studded wall

Generally acceptable. Compression fittings should not be placed in studded walls and there should be as few joints as possible.

**GENERAL:** Always position cold water pipes **BELLOW** hot water and central heating pipes. This will help prevent undue warming of the cold water supply.

Pipework in areas of the building subject to frost

Pipework that is installed in vulnerable positions within the dwelling must have insulation protection:

- Unheated cellars
- Roof spaces
- Under ventilated suspended floors
- Garages
- Outbuildings

Weight distribution of cisterns and heavy components

By placing components such as cisterns on platforms that have a larger surface area, it distributes the load and places less stress on the building structure. Take a look at the example below:

A plumber is installing a cistern measuring 1m x 1.1m x 0.9m in a roof space. The cistern has a volume of 0.99m$^3$.

$$1m \times 1.1m \times 0.9m = 0.99m^3$$

To convert this into litres capacity:

$$0.99 \times 1000 = 990\text{litres}$$

Since 1 litre of water weighs 1kg @ 4°C, then 990litres = 990kg

So, the cistern has a mass 990kg. But what is the weight of the cistern on the roof trusses? Weight is measured in Newtons, so we must first convert the kg to N

$$Kg \times 9.81 = N$$

So:

$$990 \times 9.81 = 9711.9 \text{N}$$
Therefore, the cistern has a force of 9711.9 N

The formula for finding the pressure exerted is:

\[ \text{Pressure} = \frac{\text{Force}}{\text{Area}} = \text{Pressure} \]

Area of the bottom of the cistern:

\[ 1\text{m} \times 1.1\text{m} = 1.1m^2 \]

\[ 9711.9 \div 1.1 = 8829N \text{ pressure} \]

But what if the area of the cistern was enlarged by placing on a platform that covers a greater surface area?

The plumber decides to build a 1.5m x 1.5m platform to stand the cistern on.

\[ 1.5\text{m} \times 1.5\text{m} = 2.25m^2 \]

\[ 9711.9 \div 2.25 = 4316.4N \]

Therefore, by increasing the surface area, the weight of the cistern on the trusses is less than half of what it was. This puts less strain on the roof structure.

AC5.7 State how to select clips and brackets appropriate to the cold water system pipework and the industry recommended spacings

The selection and installation of pipe clips was covered in detail in Unit D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems, LOS, AC5.1 State how to measure and mark out for fixings to pipework and plumbing and heating components.

AC5.8 Identify how to position, fix and connect new cold water pipework to outlets

As with all appliances, there is often more than one way to connect them to the water system, hot or cold. In many instances, the tap will dictate how the connection is made.

Bath taps or shower mixer valves, Washbasin taps and Sink taps

In most instances, the type of tap installed will dictate the connection made. Bath taps usually require tap connectors, even if a mixer-type tap is installed. Washbasin and kitchen sink taps also use tap connectors, unless the tap is a monobloc mixer-type. Monobloc taps have 10mm or 15mm tails for connection with standard copper fittings. Occasionally, the connection may be by a flexi-connector with a compression connection to connect to the pipework.
Combination boilers use manufacturers compression connections to a purpose-designed jig. The manufacturer’s instructions must always be followed when connecting these appliances as most require that copper tube is used and not plastic pressure pipe.

WC flushing cistern

WCs usually require tap connectors to the float operated valve. However, flexi-connectors may also be used. In all instances, an isolation valve must also be fitted.

Cold water storage cistern

A rigid copper tube connection is recommended via a tap connector to prevent reverberation and water hammer caused by the float operated valve. In all instances, an isolation valve must also be fitted.

AC5.9 Identify suitable methods of making new pipe work connections into existing cold water system pipework

Existing systems can be very difficult to work on, especially if the pipework is more than 40 years old. Before 1973, the imperial system of measurement was used in the UK. This meant that all pipe sizes were in inches rather than millimetres and in most cases, the sizes were not compatible with the SI system sizes. Over the last 100 years, cold water systems have used a variety of materials and each one brings its own unique problems when trying to make connections to existing systems.

Copper

Copper tube has been around since the 1940’s in one form or another. There are 3 main types of existing copper tube:

- **20 thread copper tube** – this was thick walled threaded copper tube that used brass fittings that screwed on to the pipe in the same way that LCS pipe does today. It was called 20 thread simply because the tube and fittings had 20 threads to the inch. You may still come across this in older properties. Jointing is notoriously difficult and requires a special endfeed-type adapter to convert it to modern copper tube sizes.

- **BS659 Copper tube** – Introduced in the 1950’s, ‘659 copper tube had a much thicker wall than modern copper tube. The jointing techniques were very similar to modern copper compression and capillary fittings. Capillary fittings were usually made from brass. Imperial sized pipework can be jointed to modern sizes provided the correct size adapter is used. These are available from most plumbers merchants.

- **BS2871 Copper tube** – There are no problems connecting to BS2871 copper tube as all sizes are compatible with BSEN1057.

Plastic

Again, there are many types of plastic that have been used for cold water supply over the years:
- High Density Polyethylene (HDPE) – This was mainly used for below ground services that lead from the boundary stop valve to the property. There were four grades – A, B, C and D. compression fittings are still available for this pipe. Each grade had a different wall thickness, so the correct insert must be used when making a joint.

- CuPVC (Chlorinated Unplasticised Polyvinyl Chloride) – This was known as ‘PolyYork’. This pipe system was used in some parts of the UK during the 1970’s. It used a solvent cement-type jointing system that required much care when making the joint. Joints had to be left for 24 before testing could take place. It was used for cold water supplies only. It is very brittle and readily snaps if mis-handled. Fittings are still available from some plumbing supply specialists.

- Acorn (polybutylene) – this was the predecessor to Hep2O and Speedfit type piping systems and used a very similar type of fitting. Sizes are compatible to copper tubes at 15mm, 22mm and 28mm, so Hep2O and Speedfit fittings may be used provided a pipe insert is used. Type A compression fittings may also be used.

**Lead**

There are still many properties in the UK that have a lead cold water supply and, considering the Water Regulations, making joints can be problematic. There are occasions when making joints on lead pipes cannot be avoided. Lead to copper joints are acceptable providing that we do not reconnect to the lead downstream. Lead – copper – lead joints can cause galvanic corrosion to occur, which can cause lead contamination at outlets and taps. Leadloks are the most common lead- copper joint system but philmac plastic fittings can also be used. It should be remembered, however, that the water undertakers suggest that all lead pipework contained within a system is removed and replaced with a more suitable medium, such as copper or plastic.

**Galvanised steel**

Making a connection to an existing galvanized steel pipework system is extremely difficult and may require the use of hand held, portable threading equipment.

**AC5.10 Identify the insulation requirements of cold water system components**

The Water Supply (water fittings) Regulations states that pipework, fittings and components need to be insulated. This is for two reasons:

a) To stop the water within the system from becoming too warm

b) To protect the system against freezing in cold weather.
Insulating pipework, fittings and components delays the effect of warming or freezing. No matter how much we insulate, if the temperature becomes cold enough, pipes will freeze. The act of insulating does not prevent the adverse effects of temperature, it merely delays them. Insulating helps to retain the heat already in the system. The thicker the insulation, the longer the system will retain the heat.

The Water Regulations Guide G4.2 states:

‘All cold water fittings located within a building but outside the thermal envelope, or those outside the building must be protected against damage by freezing.’

Pipework that is installed in vulnerable positions within the dwelling must have insulation protection:

- Unheated cellars
- Roof spaces
- Under ventilated suspended floors
- Garages
- Outbuildings

Where pipework is installed in roof spaces, the pipework should be insulated even if it is placed underneath the fibreglass insulation blanket. This is so that any heat that passes through the ceiling from the room below does not unduly heat the water.

The thickness of the insulation will depend on the size of the pipework and its location. Pipework installed outside the dwelling should be insulated with external insulation that is waterproof.
Cisterns should be insulated with a PVC wrapped fibreglass jacket. Cisterns in roof spaces should have the fibreglass roof insulation below them removed. This will allow some heat from below to filter upwards to help prevent the cistern from freezing.

The effectiveness of insulation materials

Recommended insulation materials are:

a. Rigid phenolic foam (less than 0.020 W/m²K)

b. Polisocyanurate foam (0.020 – 0.025 W/m²K)

c. PVC foam (0.025 – 0.030 W/m²K)

d. Expanded polystyrene, extruded polystyrene, cross-linked polyethylene foam and expanded nitrile rubber (0.030 – 0.035 W/m²K)

e. Expanded synthetic rubber, cellular glass and standard polyethylene foam (0.035 – 0.040 W/m²K)

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<th>Thermal conductivity of insulation material at 0°C (W/m²K)</th>
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Insulation thicknesses marked * limit ice formation to 50% after 9,8 and 7 hours respectively. All other figures not in brackets limit ice formation to 50% after 12 hours. Insulation thicknesses marked in brackets () are those recommended for 12 hour protection from freezing based on an air temperature of -6 °C and a water temperature of +7°C

Pipework insulation should conform to BS5422 and be fitted in accordance with BS5970. It should be water and moisture proof and resistant to mechanical damage and vermin attack.
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Learning Outcome 7

Know the service and maintenance requirements of cold water systems and components
There are four Assessment Criteria in Learning Outcome 7:

**AC7.1.** Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of cold water system components.

**AC7.2.** Identify how to carry out routine checks on cold water system components as part of a periodic maintenance programme.

**AC7.3.** State the procedures for dealing with defects in cold water components and pipework.

**AC7.4.** Identify the types of information to be provided on a maintenance record for cold water systems.

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**AC7.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of cold water system components**

The maintenance of cold water systems is an important task, which ensures that systems and components continue to give good service throughout their working life. The system will require temporary decommissioning to allow the maintenance to take place.

Cold water systems maintenance is usually completed to a set maintenance schedule, often undertaken out-of-normal working hours if the supply cannot be interrupted during a normal working day. Planned maintenance may include:

- System inspection and checking for leaks.
- Maintenance of Float Operated Valves.
- Maintenance of terminal fittings and taps.
- Inspection and cleaning of cisterns.
- Re-adjustment of water levels in cisterns.
- Re-washing of drain valves.
- Cleaning of filters and strainers.
- Maintenance of water softeners.
- Check correct operation of stop valves.
- Checking flow rates at outlets.

Where appliance servicing is carried out, the manufacturer’s instructions should be consulted to see if there are any special requirements or tasks that need to be performed. Manufacturer’s data usually includes a list of replacement parts with part numbers. A record of all repairs and maintenance tasks should be recorded on the maintenance schedule, including when and where they were completed and the type and number of tests performed. This will provide a record of past problems.
AC7.2 Identify how to carry out routine checks on cold water system components as part of a periodic maintenance programme

Visual inspection of pipework for leakage and adequate support

A visual inspection of any visible pipework should be carried out during an annual maintenance to look for:

- Any physical signs of leakage, such as water around joints, water on floors or discolouration of fittings etc. Where pipes are concealed, check for damp patches on walls and ceilings as this is a good indication that a pipe may have started to leak.
- Adequate clipping, such as missing or broken pipe clips and brackets, damaged or vandalised pipe work etc.

Effective operation of terminal fittings

Terminal fittings, such as taps and mixing valves often show signs of wear by dripping constantly. A dripping tap could be due a worn washer, a worn seat or a combination of both. Taps also show signs of leakage through spindles and seals. The most effective way of checking a tap is by simply turning it on and off:

- Is the tap dripping?
- Does turning the tap on cause water to leak through the spindle?
- Is the tap difficult to turn off?
- Are there any signs of dripping elsewhere, such as a mark under the outlet of the tap on the appliance? This often shows as a blue/green stain on washbasins.

If the answer to any of these questions is ‘yes’ then the tap washer and seating should be checked and repaired as necessary. Spindle leakage may mean that the packing gland around the spindle has worn and this may need repacking with PTFE tape.

Effective operation of float operated valves

Float Operated Valves often pass water at night when the pressure rises outside the hours of peak demand. Check:

- The water level in the cistern where the FOV is fitted. Are there any signs of a water line above the present shut-off level? This could indicate it may be passing water.
- Open a tap and watch the FOV when the water level drops. Does the FOV open smoothly? Does it shut off without pipe noise or reverberation?
Effective operation of stop and service valves

See ‘Effective operation of terminal fittings’ above. Since most stop valves are based around the same technology as terminal fittings, the same methods apply.

Isolation valves and gate valves should be checked for signs of corrosion. To check whether they are working correctly, gently turn them off and check to see if they have isolated the appliance or system they are serving. If not, they should be replaced.

Condition of protected cold water storage cistern.

Plastic cold water cisterns should be inspected regularly for signs of distortion. Inspect the inside for debris on the bottom of the cistern and clean as necessary. Check the base that the cistern is sitting on for signs of leakage. Check that the insulation is intact and adequate.

AC7.3 State the procedures for dealing with defects in cold water components and pipework

Cistern failure

Cistern failure leads to much damage by flooding. Regular inspections of cistern often gives sufficient warning that a problem is developing. However, cisterns can suddenly start leaking purely because of the amount of water they hold or the way they have been installed. Cisterns can split around the holes made for the pipe connections, especially if those holes have been made incorrectly or are too big or slightly too small. Galvanised steel cisterns rust and often the severity of the rusting is missed during inspections.

The best way to deal with failures of this sort are:

- Isolate the cold water inlet supply to the FOV and place a warning notice at the isolation valve that it is not to be turned on.
- Open as many taps that are being fed from cistern as possible and completely drain the cistern.
- Remove and replace the cistern, making sure that it is well supported and installed to the Water Regulations and the recommendations of the manufacturer.

Incorrect support to cold water system pipework and storage cisterns

Incorrect cistern support creates problems, especially if the cistern is made of plastic. Not enough support leads to deformation of the plastic, which causes stress on the pipework connections, often leading to leakage. When problems of support are found, they should be rectified as soon as possible. Do not try to remedy this when the cistern is full. It should be isolated and drained down first and any pipework alteration completed to ensure that the problem is
Unsupported pipework creates noise and often leads to further damage and leakage. This subject is dealt with in the next section.

**Excessive noise in pipework systems**

Noise in pipework can be caused by many factors:

- **Faulty tap washers** – these can either squeal or hum when the tap is opened. Replacing the washer often cures the problem.

- **Faulty FOV washers** – again these can hum very loudly when water passes over them. The noise is amplified by the roof space and the pipework. Again, replacement is often the best cure.

- **Loose pipework** – This is not only annoying but can cause further damage to pipework and fittings. When pipework bangs when a tap is closed, the bang often relates to moving pipework, often around an elbow or tee branch. Each bang is the equivalent of twice the incoming pressure of the cold water supply. This can often lead to further pipe damage and fittings failure. The best way to prevent such noise is to locate and secure the pipework. However, if this is not possible, then a water hammer arrester can be fitted in the pipework as near to the incoming supply stop valve as possible and this may cure the problem.

- **Excessive noise** is also caused by pipework that is too small for the amount of outlets it has to supply. Remember! Flowrate + pressure = NOISE!

**Leakage of internal cold water system pipework and fittings**

When dealing with leakage, the first action is to isolate the water and drain down the pipework, thereby preventing further damage. The method of repair will depend on the type of pipework material.

**Leakage from below ground cold water service pipework**

Leakage from below ground pipework often first shows itself as a loss of pressure and flowrate at the taps of the property. Leaking pipework of this nature not only leads to water loss but can also damage the footings of the building. Below ground leakages are notoriously difficult to find and often requires the help of the water authority to discover them. In most cases, a below ground leak leads to complete replacement of the supply pipe. Remember, if it is the supply pipe that is leaking, it will be the responsibility of the building owner, if it the communication pipe, it will be replaced by the water authority.

If the leak can be pinpointed, it will require digging out and the leak repairing. MDPE, HDPE and copper pipework can be repaired fairly easily. Lead pipework,
however, should be completely replaced with new pipework.

Leakage or ineffective operation of Terminal fittings, Float operated valves and Stop and service valves.

Terminal fittings taps are quite easy to repair providing that you follow the procedures set out below:

**The procedure for re-washering a BS1010 tap with a rising spindle**

1. Ensure that the water supply is isolated and the pressure relieved by opening the tap.
2. Put the plug into the sink to prevent any dropped small screws and nuts from disappearing down the sink waste.
3. Locate the screw which holds the tap head on to the spindle and carefully remove with a screwdriver.
4. Carefully remove the tap head. These can often prove difficult to remove especially if the tap has not been serviced for a few years, so care must be taken to prevent damage to the appliance.
5. With the head removed, break the joint between the tap head workings and the tap body using an adjustable spanner. Use a pair of water pump pliers to counteract the force of the adjustable spanner on the head workings. This prevents the whole tap from spinning around. Using a cloth in the jaws of the water pump pliers prevents damage to the tap body.
6. Remove the jumper plate and washer from the spindle. If the jumper is a fixed jumper, a little force may be needed to free it.
7. Remove the washer from the jumper plate. Some rubber tap washers are held on by a small brass nut. Carefully remove the nut and replace the existing rubber washer with a new rubber washer of the correct size. When screwing the washer nut back, only screw it hand tight.
8. Remove the packing gland nut and remove the spindle by fully winding in a clock wise direction. It can now be taken out and cleaned of any scale build up.
9. Re-grease the spindle only using silicon grease.
10. Push the spindle back through the packing gland and fully wind until the tap spindle is in the fully open position.
11. Check the packing in the packing gland. Packing glands can often work loose during use, causing the tap to leak water through the spindle. Replace the packing with a PTFE grommet if necessary.
12. Squeeze a small amount of silicon grease into the packing gland before replacing the packing gland nut. Do not tighten the nut at this stage.
13. Re-insert the jumper plate into the spindle.
14. Check the seat of the tap. The seat is the part where the washer sits to shut off the water. If there are any grooves or pits in the seat, it will require re-seating. If the tap requires re-seating, use the tap reseating tool with correct size grinding head and reseat as necessary.
15. Check the fibre sealing washer on the head workings. These create a water tight seal between the head working and the tap body. They often break when the tap head is removed. If the fibre sealing washer needs replacing, this can be done using PTFE tape.
16. Make sure that tap head workings is in the fully open position and return the head workings into the tap body and tighten using the adjustable spanner.
17. Tighten the packing gland nut. Do not over tighten as this will make the tap hard to turn on.
18. Replace the tap head but do not secure with the screw at this point.
19. Turn on the water with the tap open. This will ensure that any debris from reseating will be washed out of the tap.
20. Turn off the tap and check for any drips
21. Replace the tap head securing screw.

The procedure for re-washing a BS5412 tap with a non-rising spindle

1. Ensure that the water supply is isolated and the pressure relieved by opening the tap.
2. Put the plug into the sink to prevent any dropped small screws and nuts from disappearing down the sink waste.
3. Locate the screw which holds the tap head on to the spindle and carefully remove with a screwdriver.
4. Carefully remove the tap head.
5. With the head removed, break the joint between the tap head workings and the tap body using an adjustable spanner. Use a pair of water pump pliers to counteract the force of the adjustable spanner on the head workings. This prevents the whole tap from spinning around. Using a cloth in the jaws of the water pump pliers prevents damage to the tap body.
6. Fully unwind the spindle clockwise until the hexagonal barrel falls away the head workings.
7. Carefully remove the rubber washer and replace with the correct size washer. Since there are many different sized washers for BS5412 taps, a tap washer kit may be required.
8. Carefully remove the circlip with circlip pliers and push the spindle downwards. This will remove the spindle from the head workings.
9. Check and replace the spindle ‘O’ ring seals if required.
10. Re-grease the spindle with silicon grease, re-insert the spindle into the head workings and replace the circlip.
11. Check the hexagonal barrel for any signs of scale. Depending on how bad it is, this can be cleaned with a small, fine file or a cleaning pad.
12. Re-grease the barrel using silicon grease and carefully re-wind back into the head workings so that the tap head is in the fully open position.
13. Check the tap seating and re-seat using the tap reseating tool if necessary.
14. Check the rubber ‘O’ ring seal on the tap head workings. Replace if damaged or loose. PTFE tape can be used if the correct size ‘O’ ring is not available.
15. Replace the head workings into the tap body and re-tighten into the tap body.
16. Replace the tap head but do not secure with the screw at this point.
17. Turn on the water with the tap open to make sure that any brass shavings from the tap reseating will be washed out of the tap.
18. Turn off the tap and check for any drips
19. Replace the tap head securing screw.
Maintenance of ceramic disc taps

Ceramic disc taps can be repaired using a special repair kit. However, the most effective way of preventing problems with ceramic disc taps is by simply replacing the head workings. These can be purchased from most plumbers merchants or ordered on-line direct from the manufacturer. Most ceramic heads are not generic and a like-for-like replacement is often required.

Float operated valves

Repairing a BS1212 Part 1 Float operated valve (Portsmouth type)
Portsmouth valves can only be repaired if a is part of an existing installation. To repair a Portsmouth valve, follow the steps listed below:

1. Turn off the isolation valve to the FOV.
2. Remove the FOV by loosening and un-screwing the union nut.
3. Remove the end cap on the valve body.
4. Remove the split pin holding the float arm to the valve body and remove the float arm.
5. Remove the piston from the valve body and inspect it for signs of wear or scale build up.
6. For nylon pistons, simply replace the washer.
7. For brass pistons, the washer is held at the end of the piston by a retaining cap, which will need to be unscrewed to allow the washer to be removed. To remove the retaining cap:
   a. Place a flat blade screwdriver in the slot for the float arm and unscrew the retaining cap. This can usually be done using a pair of pliers.
   b. Remove the washer and replace.
   c. Replace the retaining cap and tighten.
8. Remove the orifice from the FOV body and check to ensure that there are no visible signs of wear or damage, such as cracks or splits at the orifice opening. Orifice’s can be purchased from local plumbers merchants.
9. Re-assemble the valve making sure that the washer is towards the orifice.
10. Put back the split pin into the valve ensuring that it passes through the hole in the float arm and open it with a screwdriver to ensure that it does not fall out.
11. Re-install the valve into the cistern, making sure the fibre sealing washer is in place.
12. Re-tighten the union and turn on the water.
13. Check the operation of the valve, adjusting the water level if needed.

Repairing a BS1212 Part 2/3 Float operated valve (diaphragm type)
These have a large diaphragm or pancake type washer that is easily accessible for replacement. To replace the washer, follow the steps below:

1. Turn off the water supply to the FOV.
2. Remove the FOV by loosening and un-screwing the union nut.
3. Unscrew the large washer retaining union and float arm at the front of the valve and remove the washer.
4. Replace the washer. It is possible to install these the wrong way round so ensure that it is fitted the correct way.
5. Replace the large washer retaining union and float arm. There is a small notch at the top of the valve to ensure that the plate is fitted upright. Make sure that the corresponding lug on the plate is engaged into the retaining notch and hand tighten the union.

6. Check that the orifice is in good condition with no cracks or splits.

7. Re-install the valve into the cistern, making sure the fibre sealing washer is in place.

8. Re-tighten the union and turn on the water.

9. Check the operation of the valve, adjusting the water level as necessary with the float arm adjustment screw.

Stop and service valves.

Most service valves cannot be repaired and replacement is the only option. Most stop valves can be repaired following the procedure for BS1010 taps above.

AC7.4 Identify the types of information to be provided on a maintenance record for cold water systems

For large cold water systems, it is advisable to keep a record of all maintenance and repairs for future reference. The types of information noted should be:

- The name of the maintenance engineer
- The date and time the maintenance/repairs were carried out
- The type of maintenance/repairs undertaken
- Their location
- The materials/components or replacement parts used
- The location of manufacturer’s instructions/maintenance data.
- The flow rates and pressures of outlets, taps and components
- The temperature of the cold water for legionella protection
Learning Outcome 9

Know the decommissioning requirements of cold water systems and components

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Cold Water System turned off

Do not turn on!
There are five Assessment Criteria in Learning Outcome 9:

AC9.1. Identify the working methods that reduce the time periods during which cold water systems need to be isolated.

AC9.2. State the information that needs to be provided to other persons before decommissioning work takes place.

AC9.3. State how to temporarily decommission cold water system components and connecting pipework systems.

AC9.4. Identify the work sequences for permanently decommissioning cold water system components.

AC9.5. Identify the methods used during the decommissioning process to prevent the end-user from operating cold water system components.

AC9.1 Identify the working methods that reduce the time periods during which cold water systems need to be isolated

AC9.2 State the information that needs to be provided to other persons before decommissioning work takes place

There are instances where cold water systems must be temporarily de-commissioned to allow essential works, such as repairs and servicing, to be conducted. The impact of isolation means that some parts, and in a worst-case scenario, all of the system will need to be isolated. There are, however, methods we can employ to lessen the impact of isolation on the customer:

1) Do as much preparation beforehand as possible. If, for instance, you are connecting an extension to the cold water system, make the final connection to the water system the last operation, so that the water is off the minimum amount of time.

2) Be frank with the customer and tell them how long the system will be off. Point out that this is an estimated time and the water will be turned back on as soon as is possible.

3) Tell the customer which parts of the system you will be working on.

4) Ask the customer to collect water for drinks in saucepans and jugs and water for ablutions in a bucket. They may not be needed but at least the customer will have some water for those essential things.

Isolating water supplies can be very annoying and inconvenient to a customer but most cases you will find that the customer is very understanding of the situation.
AC9.3 State how to temporarily decommission cold water system components and connecting pipework systems

This is where a water system or part of a water system is isolated and drained down so that work may be performed on it. Once the work is completed, the water will be turned on and the system put back into operation.

The customer must be the focus when isolating water supplies. Water is vital for the day-to-day running of a household. Therefore, keeping them informed of the sequence of operations allows them to make informed choices about bathing, clothes washing, food preparation etc. Below is a suggested sequence of events:

1) Inform the customer that the water supply is going to be isolated and inform them as to how long the supply is expected to be off.

2) Suggest that they might like to collect some water for drinking etc.

3) Ensure that those appliances that are using or may be using water supply are turned off. Ask the customer not to turn on any clothes or dish washing machines. Ensure that the electrics to any combination boilers are turned off. This is to ensure that the boiler does not fire up while the water is off. It is purely precautionary.

4) Isolate the system or part of the system that is being worked on.

5) Drain the system of water at the nearest drain point.

6) Place a warning notice at the point of isolation warning other people that the supply is turned off and is not to be turned back on.

AC9.4 Identify the work sequences for permanently decommissioning cold water system components

Unlike temporary de-commissioning, permanent de-commissioning of a system literally means that the system will not be re-instated. In most instances, this will mean the complete removal of all pipework and appliances. The pipework should be cut back to the nearest live connection and capped to prevent stagnation of the water supply:

1) Isolate the water supply at the point where the system is to be decommissioned.

2) Completely drain the system of water at the nearest drain point.

3) Remove all appliances and carefully remove the pipework and clips.

4) Cut the pipework back to the stop valve or nearest live connection and cap the pipe off.
5) If necessary, a notice can be left by the stop valve informing that the system has been permanently de-commissioned and is not to be turned on.

AC9.5 Identify the methods used during the decommissioning process to prevent the end-user from operating cold water system components

This subject was covered in depth in AC9.1 to AC9.4. Please see above.
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Learning Outcome 11

Know the inspection and soundness testing requirements of cold water systems and components
AC11.1 State the checks to be carried out during a visual inspection of a cold water system to confirm that it is ready to be filled with water

Filling any system with water is the time when we see if the system is watertight. Pressure testing confirms the water tightness ready for the next stage of bringing the system into operation. Before these operations can take place, a visual inspection of the system should be made to confirm that the installation is correct and meets the required standards:

- Check that all open ends have been capped and/or all valves have been isolated.
- Check that all taps and outlets have been turned off and any drain valves are closed.
- Isolate any service valves and gate valves.
- Check all visible joints to ensure that they have been properly made. Check that capillary joints have been wiped clean of any excess flux as this can cause corrosion in later life.
- Check that enough pipe clips have been installed and that the pipework is secure.
- Check that tap connectors and compression fittings are tight.
- Ensure that any automatic air valves are open.
- Ensure that a provisional fill level has been set in any cold water cisterns fitted.
- Check that all cisterns have been fitted correctly and are well supported.
- Check that cistern lids are left in place.

AC11.2 State how to fill cold water pipework with water at normal operating pressure and check for leakage

There is little point to pressure testing cold water systems if it leaks at normal operating pressure. The point to testing at normal operating pressure first is to see if the installation is at least water tight before the system
Testing is best done in stages or by zones:

1) Seal any open ends of pipe with isolation valves and turn off all isolating valves.
2) Attach the test bucket at a low point in the system and pump the test bucket until the pressure in the system is equal to the normal operating pressure.
3) Check for leaks.
4) Visit each isolation valve at each zone or section and turn on.
5) Pump the pressure up until the pressure gauge reads normal operating pressure.
6) Check for leaks
7) At each capped draw-off point, open the isolation valve until water is received at that point. Turn off the isolation valve.
8) Pump the pressure up until the pressure gauge reads normal operating pressure.
9) Re-check for leaks.

Once this has been completed, then the system can be pressure tested in accordance with the Water Supply (water fittings) Regulations 1999.

In occupied properties, some installers wait until the appliances are fitted and connected before completing the testing of systems and it is up to the discretion of the installer when initial fill and soundness tests are completed.

AC11.3 Identify how to carry out a soundness test to industry requirements on cold water systems pipework and components

The testing requirements of cold water systems was covered in detail in D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems

Learning Outcome 9: Know the inspection and soundness testing requirements of domestic plumbing and heating pipework

AC9.2 State how to carry out a soundness test on domestic plumbing and heating pipework
AC11.4 State the flushing procedure for cold water systems and components

Again, like testing, the flushing procedure for water systems differs from installer to installer. Some Plumbers like to flush the pipework through before making the final connections to the appliances. The benefits of doing this are that the chances of dirt and debris getting into sensitive workings of taps and valves is greatly reduced. Others will wait until the system is complete and ready for commissioning before flushing the system through. Either way, flushing with water taken direct from the water undertakers cold water main before the system is commissioned is a mandatory requirement and an important aspect of the installation as it removes dirt and debris as well as the excess flux and jointing pastes used during the installation. Remember, systems should be flushed every time the system has been worked on and definitely after major alterations or additions. There is no requirement at present to disinfect domestic buildings although large systems, such as apartment blocks should be disinfected. Disinfection of water systems is discussed at Level 3.

The following method is a basic flushing sequence:

1) Ensure that all isolation valves and terminal fittings are turned off.
2) Turn on the internal mains cold water stop valve.
3) Turn on individual sections from the isolating valves, ensuring there is no leakage.
4) Visit each terminal fitting, valve and tap individually and turn on.
5) Flush the system through until the water runs clear and then let it run for 20 – 30 seconds.

AC11.5 Identify the actions that must be taken when inspection and testing reveal defects in cold water systems

Faults that are immediately obvious during inspection will require rectifying before testing takes place. Problems such as loose pipework and general lack of fixings are easily fixed. Some initial problems, such as inadequate support for cisterns, may take longer to remedy.

Problems that arise during initial testing are generally centred around leakage that will require fixing as a matter of urgency.

There may also be problems that arise during the commissioning stage, such as failure to meet the requirements of the specification, lack of flow rate or pressure or unsatisfactory performance of fitted components and appliances. Where problems of this nature occur, then the system designer must be informed, and a remedy sought as a matter of urgency. In these cases, reference to manufacturers data should be made.