Section 9 – F/602/2917

Understand and apply domestic rainwater system installation and maintenance techniques
F/602/2917 - Understand and apply domestic rainwater system installation and maintenance techniques

This combination unit provides learning in the installation and maintenance of gravity rainwater systems that are installed on dwellings and industrial/commercial properties (of similar size and scope to domestic dwellings) in buildings up to 3 storeys in height. Upon completion the learner will:

LO1. Know the general principles of gravity rainwater systems
LO2. Know the layout requirements of gravity rainwater systems
LO3. Know the site preparation techniques for gravity rainwater systems
LO4. Be able to apply site preparation techniques for gravity rainwater systems
LO5. Know the installation requirements of gravity rainwater systems
LO6. Be able to install gravity rainwater systems
LO7. Know the service and maintenance requirements of gravity rainwater systems
LO8. Be able to service and maintain gravity rainwater systems
LO9. Know the inspection and testing requirements of gravity rainwater systems
LO10. Be able to inspect and test gravity rainwater systems.

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

Know the general principles of gravity rainwater systems
There are five Assessment Criteria within this Learning Outcome:

- **AC1.1.** State the purpose of gravity rainwater systems used on dwellings
- **AC1.2.** Identify the working principles of gravity rainwater systems used on dwellings
- **AC1.3.** State the common gravity rainwater system component materials
- **AC1.4.** Identify the different types of gutter systems used on dwellings
- **AC1.5.** Identify the different types of rainwater pipework used with gutter systems on dwellings

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**AC1.1 State the purpose of gravity rainwater systems used on dwellings**

Rain fall in the UK differs greatly. In the North-West rainfall totals around 2.4m per year whilst in the South-East around 0.5m is the norm. Rain water, as we have seen all too frequently, can inflict major damage to property both internally and externally. Gutters and rainwater systems help prevent the damage to the building by diverting the water away from vulnerable parts of the building that could be adversely affected by large amounts of rainfall. Without gutters and rainwater pipes, the water would simply run off the roof and erode the ground around the building, penetrating its structure and undermining its foundations, causing subsidence and cracks.

Modern rainwater systems can benefit modern buildings. Apart from the obvious water diversion uses, rain water, that would otherwise run to the sea, can be used in the home. Rain water harvesting systems that utilise the rainfall for other purposes such as WC flushing, can save money for the building owners and help to preserve our precious water resources for future generations.

**AC1.2 Identify the working principles of gravity rainwater systems used on dwellings**

The working principles of rainwater systems is to remove water from rainfall away from buildings, so that it does not constitute a nuisance to the buildings occupants or create damage to the buildings structure or foundations.

Domestic gutter systems work by collecting the rainwater that runs off roofs into channels, known as gutters and discharging safely away from the building by gravity via rain water pipes into one or a combination of the following:

- **A surface water drain** – With the separate system of building drainage, rainwater discharges down a dedicated surface water drain (often called a top water drain).
- **A combined drainage system** – both foul water and surface water discharge down the same sewage system.
• **A water course** – rainwater discharges directly to a stream or river.

• **A soakaway drain** – a pit with a minimum of 1m x 1m x 1m dimensions filled with rubble designed to let the water soak naturally away to the water table below ground.

• **A rainwater harvesting system** – a method of collecting rainwater for use within a property for flushing WCs and clothes washing.

### AC1.3 State the common gravity rainwater system component materials

#### PVCu

**BSEN607:2004**  
**BSEN122001:2000**

<table>
<thead>
<tr>
<th>Advantages of PVCu</th>
<th>Disadvantages of PVCu</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Smooth internal bore gives better flow rates</td>
<td>• Greater co-efficient of linear thermal expansion at 0.06mm/m/°C when compared to other guttering and rainwater materials.</td>
</tr>
<tr>
<td>• Light in weight making it easier to handle</td>
<td>• Tends to go brittle in very cold temperatures</td>
</tr>
<tr>
<td>• Very little maintenance required when compared to other materials such as cast iron</td>
<td>• Softens at relatively low temperature.</td>
</tr>
<tr>
<td>• Does not suffer from corrosion like other gutter and rainwater materials</td>
<td>• Can be affected by wood preservatives because of the solvent content</td>
</tr>
<tr>
<td>• Easy to joint and install</td>
<td>• Colour can fade in direct sunlight</td>
</tr>
<tr>
<td>• Various colours available means little or no painting</td>
<td></td>
</tr>
<tr>
<td>• An expected lifespan of 50 years</td>
<td></td>
</tr>
</tbody>
</table>

#### Extruded Aluminium

Extruded seamless aluminium guttering systems are usually installed by specialist companies. It is very lightweight and corrosion resistant. Most gutters of this type are formed on site by a special machine that presses the gutter into the required profile from a roll of aluminium sheet. Because it is light and flexible, strengtheners are fitted to the gutter to give added rigidity before it is installed.
Advantages of extruded aluminium

- It has strength and flexibility and is very light in weight
- Long continuous lengths means fewer joints
- Less leakage than other gutter systems
- It can be formed in many profiles and colours
- Very little linear thermal expansion

Disadvantages of extruded aluminium

- The initial cost is expensive
- Not suited for properties attached to other properties unless all buildings are having extruded aluminium installation

Cast Iron gutters can be seen on many older properties and may still be fitted to buildings that want to retain the ‘period’ feel. It is still used on many of the UKs listed and historic buildings and even in local authority conservation areas.

Cast iron is strong but can be very high maintenance, requiring regular painting to prevent corrosion. Internally, cast iron has a fairly rough surface and this often means regular cleaning out of blockages and silt build up.

Advantages of extruded aluminium

- It has strength
- Maintains the character of older historic buildings

Disadvantages of extruded aluminium

- Cast iron is expensive to purchase and time consuming to install.
- It is very heavy
- Requires regular maintenance
- Jointing is very messy and time consuming

AC1.4 Identify the different types of gutter systems used on dwellings

In the last 200 years, rainwater and gutter systems have been manufactured in a variety of styles and shapes, from the simple lead lined box gutter to the more elaborate ornamental gutters or OGEE gutters, used to good effect on Victorian buildings from around 1850. Today, modern gutter profiles add much to the look of a building. Choosing the right type of gutter for the building is aesthetically important, especially when replacing old, worn gutters for new. Maintaining the ‘period’ feel of the building can enhance the overall look.

There are four main gutter profiles in use today. These are shown below:
Half round
This is probably the most common and widely used gutter profile used in the UK. It gives good flow when laid to the correct fall, with little sediment build up.

High capacity/Deep half round/storm flow
Similar in appearance to half round gutter but with a much deeper profile. It is slightly elliptical in shape and generally used where the roof area is large or steep angled. Specifically designed for high volume flow rate.

Square Section
This type of gutter became very popular in the 1980s and 1990s and it is still used today on new build dwellings as well as replacement gutters. Caution should be exercised when replacing square section gutters or adding to existing systems as not all manufacturer’s gutters and fittings are interchangeable. Some makes are no longer available and will not fit modern equivalent shapes.

Square section has almost twice the capacity of half round section and flow rates are acceptable when laid to the correct manufacturer’s falls but it can silt up very quickly because of its flat bottom. It requires regular cleaning.

Ogee (O. G. or ornamental gutter)
A modern adaptation of a Victorian design, ogee guttering is used to very good effect on both old and new buildings alike. Modern buildings benefit from the period styling whist on refurbishments and historical renovations, ogee offers a lightweight and long-lasting alternative to cast iron gutters.

Again, caution should be exercised when adding to existing gutter systems as each manufacturer tends to have their own designs and many are not interchangeable.
AC1.5 Identify the different types of rainwater pipework used with gutter systems on dwellings

There are 2 rainwater pipe profiles. These are:

- Round section
- Square section

**Round rainwater pipes**

Round rainwater pipes can be used with all forms of PVCu gutter systems. Most manufacturer’s use 68mm diameter pipe.

**Square rainwater pipes**

Usually used with square section guttering systems. Most manufacturer’s use the same size (65mm square) and so are interchangeable.

**Other rainwater pipework materials**

- **Cast iron**
  
  Cast iron rain water pipes are specifically made for use with cast iron gutter systems. Jointing is usually done using a paint and putty method to create a water tight seal. Cast iron rainwater pipes are available in 1.8m lengths and come with a socket at one end. Attached to the socket are ears that are used to fix the rainwater pipes to the wall in conjunction with wooden spacers, known as bobbins. Bobbins are used to stand the Rainwater pipe away from the wall. See drawing left.

- **Lead**
  
  Lead pipes have been used for hundreds of years as a method of taking rainwater water away from buildings. Nowadays, its use is restricted to church and cathedral use and buildings of historic and architectural importance. Many church restorations employ specialist lead working companies to fabricate exact replicas of exiting lead pipework. This can be achieved by casting, lead welding or bossing lead sheet into the required shape.
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Learning Outcome 2

Know the layout requirements of gravity rainwater systems

RWO = Rain Water Outlet
S/W = Surface water
I/C = Inspection chamber
There are seven Assessment Criteria to this Learning Outcome:

- **AC2.1.** Identify the factors which are used to determine the type (size) of gutter system used on a dwelling.
- **AC2.2.** Identify the jointing procedures for gutter systems.
- **AC2.3.** Identify the jointing procedures for rainwater pipework materials.
- **AC2.4.** State the purpose of components used in an eaves gutter system.
- **AC2.5.** State how building features determine gutter bracket selection for buildings.
- **AC2.6.** State the purpose of components used in rainwater pipework.
- **AC2.7.** Identify the factors which are used to determine the type (size) of gutter system used on a dwelling.

**AC2.1 Identify the factors which are used to determine the type (size) of gutter system used on a dwelling.**

Before a gutter system can be chosen, there are factors that must be taken into account. It must be remembered that a gutter system to work effectively must be large enough to carry away the expected flow of water at any point on the system. Poor sizing of the system, design and installation can often lead to problems with gutters overflowing and causing damage to the building structure.

**Rainfall intensity**

In England, the North-West region has the greatest rainfall at around 1.8 – 2.0m of rainfall per year. Parts of Scotland have even greater rainfall at around 3.5m. The driest region of the UK is the South-East with only around 0.5m per year. These figures show rainfall as an overall event over a 12 month period. The figures, however change dramatically when rainfall over a 2 minute period single event are investigated. Essex, in the South-East has more rainfall in a 2m intense storm event at 0.022l/s/m² than Cumbria with 0.014l/s/m². This is known as rainfall intensity and must be used when calculating the size of the gutter system. Information and figures relating to rainfall intensity can be found in **BSEN12056-3:2000**.

**Roof area**

The volume of water discharging from any roof is dependent on the area of the roof in m² and the angle of the roof in degrees of pitch. A roof with 45° pitch will have a greater area...
than a roof of 30° pitch. The angle of the roof will also increase the velocity of the water flowing from the roof. Look at the drawing above.

The drawing shows two roofs, each with a span or width of 7m, but the roof on the left is pitched at 30° and the roof on the right is pitched at 45°. Using the calculation below taken from BSEN12056-3:2000, we can calculate the area of the each of these roofs. We will assume that both roofs have a length of 10m:

**Effective Maximum roof area (allowance for wind):**

\[ W + \frac{H}{2} \times L = \text{area in } m^2 \]

Where:

- \( W \) = Width or span
- \( H \) = Height
- \( L \) = Length

**Roof a)**

\[ 3.5 + \frac{3}{2} \times 10 = 50m^2 \]

**Roof b)**

\[ 3.5 + \frac{5}{2} \times 10 = 60m^2 \]

This clearly shows that roof b) has a greater roof area than roof a) and so will discharge a greater amount of rainfall, but we can simplify this even further.

This time, we will use the table from BR AD H3, which gives the pitch factors. By applying the pitch factor, the area of the roof can be calculated sufficiently to allow a design flow rate in l/s/m\(^2\) to be calculated. This works only if the roof pitch is known.

\[ L \times W \times \text{Pitch Factor} = \text{area of the roof in } m^2 \]
Where:

\[ L = \text{Length of the roof} \]
\[ W = \text{Width of the roof} \]

<table>
<thead>
<tr>
<th>Type of roof/surface</th>
<th>Effective design area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat roof</td>
<td>Plan area of relevant portion</td>
</tr>
<tr>
<td>Pitched roof at 30°</td>
<td>Plan area of portion x 1.29</td>
</tr>
<tr>
<td>Pitched roof at 45°</td>
<td>Plan area of portion x 1.50</td>
</tr>
<tr>
<td>Pitched roof at 60°</td>
<td>Plan area of portion x 1.87</td>
</tr>
<tr>
<td>Pitched roof over 70° or any wall</td>
<td>Elevational area x 0.5</td>
</tr>
</tbody>
</table>

Roof a)

\[ 10 \times 3.5 \times 1.29 = 45.15 m^2 \]

Roof b)

\[ 10 \times 3.5 \times 1.50 = 52.5 m^2 \]

Once the area of the roof has been calculated, this can be applied to the calculation for the expected rainwater run off for the area of the roof. Although BSEN12056-3:2000 gives the expected rainfall in l/s/m² for different areas, a generally accepted figure of 0.0208 l/s/m² can be applied:

\[ \text{Area of roof} \times 0.0208 = \text{rainfall l/s/m}^2 \]

Roof a)

\[ 45.15 \times 0.0208 = 0.939 l/s/m^2 \]

Roof b)

\[ 52.5 \times 0.0208 = 1.092 l/s/m^2 \]

Running outlet position

A running outlet is the link between the guttering system and the below ground drainage system in use via the rainwater pipe (RWP). At maximum flow conditions, it is purposely designed to be able to discharge the water flow from the gutter to the RWP from two directions.

When a severe rain storm event occurs, gutters very quickly fill with water. The more running outlets that the gutter system has, the less likely that the gutter will overflow.
Positioning of the outlets is an important aspect of gutter system design. If running outlets are placed at the end of a gutter run, then the outlet will only work at 50% of its actual handling capacity, since they are designed to be able to cope with water flow from two directions. Running outlets work much better when placed towards the centre of a gutter run than at the end. Look at the drawing below:

In drawing A, the outlet is placed at one end of a gutter run. Here, the outlet will have to cope with all of the water from the roof and because the water is only approaching from one direction, there is a very good chance that the gutter will overflow during a severe storm. Remember, running outlets are designed for rain water in two (2) directions and only one direction is being used. So, effectively only 50% of the outlet has to cope with 100% of the rainwater.

In drawing B, Running outlets are placed at either end (A and B). This is better in terms of water flow rate. Here, the outlets can easily handle the water run-off from the roof because there are two running outlets. However, with each outlet running only at 50% capacity, there is effectively only one running outlet discharge. A much better alternative in this instance would be to place one running outlet in the centre of the gutter run (shown by the dashed line at point C).

Drawing C shows the best positioning of running outlets. Now each running outlet is handling 50% of the expected rainwater flow and both are working with water flowing in two directions. This means that each side of the running outlets is only having to cope with 25% of the expected storm flow from the roof.

The fall of the gutter

For a gutter to be effective in removing rainwater from a building, it must be laid with a slight fall to
encourage the water to flow towards the running outlet. Too shallow a fall and the water will ‘pool’ in the gutter reducing the gutters potential flow handling capacity and this encourages silt build-up. Too steep an angle and the water will run too fast, which may cause the water to overflow from the gutter.

British Standard BSEN12056-3:2000 advises that the fall of the gutter should be between 1mm/m and 3mm/m. It also advises that the angle of fall of the gutter should not be so steep that the rainwater misses the front edge of the gutter as it discharges off the roof. Most gutter manufacturers (but not all) state that a fall of 1:600 or 25mm in every 15m will meet this requirement. A small number of manufacturers use a fall ratio of 1:350 or 25mm in every 8m. Both of these fall ratios will ensure that the water flows effectively and the gutter works to its maximum capacity.

Changes of direction

Changes in direction in guttering systems are often unavoidable due to the design of the roof. Angles as low as 10° can effectively slow the water flow down to the point where the gutters upstream of the angle begin to fill with water. Installing a 90° angle will reduce the effectiveness of the gutter to discharge water by 15%. This, in effect, reduces the area of roof that the gutter can cope with and the more angles that are added further reduces the gutters handling capacity.

Customer preference

Most customers will have some idea of the type of look they want their gutter system to have. Rainwater Flow rates across the range of gutter profiles is fairly consistent, although square section profile and deep half round have better capacities than half round and OG profiles. There are a wide range of colours available including white, black, brown, grey and green.

AC2.2 Identify the jointing procedures for gutter systems

Jointing PVCu gutters

PVCu gutters use a snap-fit clip retaining system to hold the gutters in place. Making a watertight joint is an easy task:

1. Cut the gutter to the required length using a hacksaw or fine-tooth wood saw.
2. Remove all burrs.
3. Insert the gutter into the joint up to the beginning of the expansion allowance gap. This allows for the expansion of the gutter. Do not insert all the way to the back stop.
4. Make sure that the gutter is...
installed underneath the back retaining clip and pull the gutter downwards into the joint while pushing the front retaining clip over the top of the gutter.

### Jointing Extruded Aluminium gutters

Unlike PVCu gutters, extruded aluminium gutters do not use a single joint design and each manufacturer tends to design their own system that is unique to that gutter profile. In general, most jointing systems are based loosely around:

1. A clip jointing system where silicone sealant is used to make the joint; or,
2. A socket and spigot system using either gutter bolts or self-tapping screws. Again, silicone sealant is used to make the joint water tight.

### Jointing Cast Iron gutters

Cast iron gutters are jointed by using the traditional socket and spigot method where the spigot fits inside the socket with a suitable jointing medium (usually bitumen paint and linseed oil putty) used to make a watertight joint. The joint is secured using zinc coated round head gutter bolts. To make a successful cast iron gutter joint:

1. Prepare the inside of the socket and the outside of the spigot by applying a coat of black bitumen paint.
2. Apply a thick bead of linseed oil putty to the socket.
3. Place the spigot inside the socket and squeeze the two halves together.
4. Push a gutter bolt through the holes and hand tighten the nut.
5. Using a screwdriver, tighten the gutter bolt. Do not overtighten as this may cause the cast iron to crack.
6. Clean off the excess putty inside and out and paint the joint (inside and out) with a coat of black bitumen paint.

Note: Special silicone sealant for jointing Cast Iron gutters is available. This is preferred when installing new cast iron gutters.

### AC2.3 Identify the jointing procedures for rainwater pipework materials

### Jointing PVCu Rainwater pipes

PVCu rainwater pipes and fittings use solvent weld cement to hold the joints together. The system is shown right:

Making a solvent weld joint is a fairly simple process but it must be remembered that solvent cement contains dangerous solvents and care must be taken to ensure that
it is used in accordance with the manufacturer’s instructions. It should not be used without first writing a risk assessment to assess the risks to the operative. In general:

1. Do not smoke, eat or drink while using solvent cement products.
2. Only use in a well ventilated space or outdoors.
3. Do not get solvent cement on your hands and avoid contact with the eyes.
4. If you feel overcome by the fumes, you must remove yourself to outside as soon as possible.
5. Solvent cement is flammable. Do not use any naked flames.

To make a solvent cement joint on PVCu pipes and fittings:

1. Cut the pipe to the required length using a finepoint wood saw or hacksaw.
2. Socket joints:
   a. Apply solvent cement to the inside of the socket first. This will allow a little time before the air gets to the cement and begins to cure it. Apply the cement lengthways in the joint.
   b. Apply solvent cement to the spigot.
3. Spigot joints:
   a. Apply solvent cement to the inside of the pipe first. This will allow a little time before the air gets to the cement and begins to cure it. The inside of the pipe in this instance acts as the socket. Apply the cement lengthways in the joint.
   b. Apply solvent cement to the spigot of the fitting.
4. Push the fitting and the pipe together with a twisting motion. This will ensure a good even covering of cement throughout the joint.
5. Wipe off any excess cement with a clean dry cloth and leave the joint to set for 5 minutes.

An alternative method of jointing would be to use the dry joint method, where pipes and fittings are simply pushed together without the aid of solvent cement. The joints are then sometimes secured in place by use of self-tapping screws.

**Jointing Extruded Aluminium Rainwater pipes**

These use a socket and spigot arrangement that are jointed using silicone sealant. The sockets are held in place by self-tapping screws.

**Jointing Cast Iron Rainwater pipes**

Again, cast iron uses a socket and spigot method to join rainwater pipes. These can be made by the use of black bitumen paint and linseed oil putty. With cast iron rainwater goods, the joints are usually made AFTER the pipework has been installed and fixed to the wall.

1. Paint the inside of the socket and the outside of the spigot with bitumen paint.
2. Fix the pipework in position on the building using spacing bobbins and large Rainwater pipe nails or large screws.
3. Squeeze putty between the joint and point the joint smooth using a flexible putty knife.
4. Paint the joint with bitumen paint.
AC2.4 State the purpose of components used in an eaves gutter system

Below is a sample of gutter and rainwater fittings and their uses:

- **Running outlet** – this is used to convey rainwater from the gutter system to the drain via the rainwater pipe.

- **Gutter angles** – changes direction of the gutter to suit the roof and gutter designs. There are many angles available including:
  - $90^\circ$
  - $135^\circ$
  - $110^\circ$

- **Gutter union** – used to join lengths of gutter together. They also act as a gutter bracket as they are fixed to the fascia board.

- **External gutter cap end** – these are used to stop the rainwater from spilling from the gutter system at the end of a gutter run.

- **Internal gutter fitting cap end** – these are used to cap off fittings. They are ideal for converting running outlets to stop-end outlets.

- **Specialist gutter adapters** – these are used when converting from one gutter profile to another. The image shows a converter from half round PVCu to cast iron OG gutters.

AC2.5 State how building features determine gutter bracket selection for buildings

Different buildings require different gutter fixing and bracketing methods. Below is a selection of gutter...
brackets and clips and their uses on buildings:

**Fascia brackets** – these fix directly to the facia board of a building. The gutter is simply clipped in place.

**Rafter irons** – also called rafter brackets, these are used where the rafters are exposed without the use of facia or soffit boards. They are made from zinc coated steel and screw directly to the top or side of the rafter.

**Rise and fall irons** – these are used where there are no exposed rafters or facia board. They are installed into the brickwork joints of the building and adjusted to give the correct fall by raising or lowering the gutter bracket by the 10mm screw threaded rod. Mainly used on older and listed/historic buildings.

**AC2.6 State the purpose of components used in rainwater pipework**

**Offsets** – often referred to as the ‘swan neck’, this is used to connect the running outlet to the rainwater

**Angles** – can be used to make offsets. Generally used for changes of direction of rainwater pipes.

**Branches** – used for connecting two rainwater pipes into one.
pipe at eaves height. They are usually made from two 135° bends.

There several angles available, including 90°, 135° and 112.5°.

**Shoes** – these are fitted at the base of Rainwater pipes where the water is discharging into a gulley.

**Hopper heads** – these are often used to collect rainwater from flat roofs or where two rainwater pipes converge at the same point. They are connected to a rainwater pipe.

**Specialist connectors** – these are used to connect the rainwater pipe to the drainage system. There several different types available.
Learning Outcome 3
Know the site preparation techniques for gravity rainwater systems
There are six Assessment Criteria to this Learning Outcome:

**AC3.1.** Identify the sources of information required when carrying out work on gravity rainwater systems

**AC3.2.** Identify the preparatory work required to be carried out to the building fabric in order to install or maintain gravity rainwater systems.

**AC3.3.** State the types of pre-existing damage to the existing building fabric or customer property that may be found before commencing work on gravity rainwater systems.

**AC3.4.** Identify the protection measures required to the building fabric or customer property, during work on gravity rainwater systems.

**AC3.5.** Identify the pipework materials and fittings required to complete work on gravity rainwater systems.

**AC3.6.** Identify the hand and power tools required to complete work on gravity rainwater systems.

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**AC3.1 Identify the sources of information required when carrying out work on gravity rainwater systems**

The installation of gutters and rainwater systems are subject to various documents and procedures to ensure that the systems we install will not be detrimental to the overall building fabric:

a. **Building Regulations Approved Document H3: 2015 – Rainwater drainage:** Document H3 is directly linked to **BSEN12056-3:2000** and contains information for both the design and installation of rainwater systems. It states that adequate provision must be made for rainwater to be safely carried away from buildings.

b. **BSEN12056-3:2000** – this document contains information regarding the calculation and design of rainwater systems. It covers subjects such as rainfall intensity, the provision of outlets, run off design and layout. Linked to **Document H3** of the Building Regulations.

c. **Manufacturer technical instructions** – every manufacturer of gutter systems and components designs and manufactures their components to comply with the Regulations and British Standards. They also advise on the best way to design and install the systems so that those requirements are adhered to. Manufacturer’s technical instructions should be consulted and followed.

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**AC3.2 Identify the preparatory work required to be carried out to the building fabric in order to install or maintain gravity rainwater 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 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.

**New systems** – on new buildings the gutters and rainwater pipes can be installed from a scaffold. Facia boards should have been previously painted and the roof finished before installation begins.

**Replacing existing systems** – Before installation of gutter and rainwater pipes can commence, the existing system must be de-commissioned and removed. This must be done with care and in such a way that the customers building structure and possessions are not damaged. This will be discussed in greater detail in AC3.3 and AC3.4.

**AC3.3 State the types of pre-existing damage to the existing building fabric or customer property that may be found before commencing work on gravity rainwater systems**

Before commencing the installation, look for the following faults, some of which may need rectification beforehand:

a. **Building wall surfaces** –
   - Damaged brickwork from previously installed rainwater pipes
   - Signs of wetness or damp on the outside wall from leaks
   - Rotted or damaged facia boards and soffits
   - Ripped or rotted under felt
   - Damaged or rotten window frames and cracked window panes
   - Damaged or missing roof tiles
   - Damaged or rotten underfelt at the facia board
   - Damaged fences or pathways.

b. **Existing gravity rainwater system components** –
   - Cracked or broken rainwater pipes
   - Broken clips and fixings
   - Leaking or broken gutters
   - Mis-matched gutters from several gutter manufacturers

**AC3.4 Identify the protection measures required to the building fabric or customer property, during work on gravity rainwater 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 3, AC3.4: Identify how to protect the building fabric or customer property before the work commences.

AC3.5 Identify the pipework materials and fittings required to complete work on gravity rainwater systems

This subject was discussed in Learning Outcome, Assessment Criteria AC1.4 and Learning Outcome 2, Assessment Criteria AC2.2 to AC2.6

AC3.6 Identify the hand and power tools required to complete work on gravity rainwater 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 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.

Generally, tools required for working on gutters and rainwater pipes will be as follows:

- Pozidrive or crosshead screw drivers
- Hacksaw or finepoint saw
- Claw hammer
- A chalk line of plumb line
- Bradawl
- A file
- A battery operated cordless drill (24v is adequate) + spare batteries.
PLUMBING STUDENT PACKAGE

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Learning Outcome 5

Know the installation requirements of gravity rainwater systems
AC5.1 Identify how expansion and contraction may be catered for in PVC-U gravity rainwater systems

PVCu has a large expansion rate when compared to other gutter materials. Gutters and rainwater pipes expand by 0.06mm/m/°C. This can lead to the gutter movement and joint leakage if the expansion is not accommodated for.

Gutter fittings have a thermal expansion mark on the joint. This is the point where the gutter is installed to and allows for around 10mm of expansion up to the gutter stop, preventing joint leakage.

AC5.2 State the positioning and fixing requirements of gutter system components

a. **Gutter brackets** – Please refer to Learning Outcome 2, AC2.5 State how building features determine gutter bracket selection for buildings for the uses of gutter brackets.

   - **Fascia brackets** – these should be installed at every 800mm centres for PVCu gutter systems
and 150mm before gutter angle (internal and external types). See also AC5.3 Identify how to install lengths of PVC-U gutter and make joints to gutter systems. Facia brackets should be screwed to the fascia with a 40mm x 10 zinc plated screw. Fascia brackets for cast iron gutters are also available.

- **Rafter brackets** – since most rafters are installed at 600mm centres, these should be fixed at every rafter for PVCu gutter systems. For cast iron gutters, there should be at least 2 brackets per 1.8m length of gutter.

- **drive-in types (rise and fall) brackets** – rise and fall brackets should be positioned to suit the material that the gutter is made from. For PVCu gutters, they should be positioned in line with the manufacturer’s installation instructions. For cast iron gutter, at least two brackets per 1.8m length of gutter.

#### Typical eaves gutter layout

- A. Running outlet position to align with the position of the gullies at ground level
- B. Internal angle position
- C. External angle position
- D. External cap end

b. **Running outlets** – these should be positioned to align with the gullies at ground level.

c. **Gutter angles** – Positioned at every change of direction.

d. **Gutter unions** – positioned as required by the gutter system design.

e. **Stop ends** – positioned at the end of a gutter run to prevent water flowing out and causing a nuisance.

- **f. Specialist unions between different gutter materials** – these are used when converting from Cast iron to PVCu (or PVCu to Cast iron). They are positioned as dictated by the installation.

**The use of cast iron to PVCu adapters**
AC5.3 Identify how to install lengths of PVC-U gutter and make joints to gutter systems

Pre-installation planning

Before gutters are installed, it is a good idea to conduct a pre-installation survey:

- **New installations/new build properties:**
  - Check that the gutter type and profile chosen will be adequate for the size of the roof and expected rainwater run-off.
  - Check that the fascia board is installed and the gullies are in the correct position.
  - Check that the under felt is in place.

- **Existing installations:**
  - Establish the type of drainage system being used and whether it is suitable for the rainwater pipework.
  - If any soakaways are being used, these should be tested to ensure they are fit for purpose and not backing up or flooding.
  - Check with the customer to see whether the existing gutter was functioning correctly and where there may be problem spots on the system.
  - Check with the customer to ensure the correct colour and profile are being installed.
  - Check that the gutter type and profile chosen will be adequate for the size of the roof and expected rainwater run-off.
  - Remove the existing gutters and check the fascia board for any signs of damage or rot.
  - Check to ensure that the building structure is sound where the rainwater pipes are being positioned.

Installing gutters

- Gutters should be laid to a fall of 1:600. Measure the length where the gutter is to be installed and calculate the required fall.

- Fix gutter brackets at the high points on the system. If the high points are internal or external corners, then the brackets should be fixed 150mm from where the end of the fitting is. (see drawing right).

- Position the running outlet over the gully using a plumb-line or string-line and fix the outlet so as
to give the required fall calculated earlier (see drawing below). Using a level ensures that the gutter will have the required fall towards the outlet.

- Now, fasten a string line between the facia bracket at the high point and the running outlet. The line needs to be tight to ensure that there is no sagging. The line will be used to position the rest of the fascia brackets.

- Fascia brackets should be fixed along the length of the string line at intervals of between 750mm and 1m, depending on whether the area suffers from heavy snow fall. In general, a distance of 800mm is usually used. Always check with the manufacturer’s instructions. Use 40mm x 10 zinc plated screws to fix the fascia brackets.

- For buildings without fascia boards: gutter brackets can be fixed using either galvanised steel top or side fitted rafter irons on which are fitted the fascia brackets. These should be spaced every rafter or as required by the manufacturer’s instructions. They are shown in position in the drawing left.

- For buildings without fascia boards or exposed rafters: Drive in rise and fall irons can be used. These are either built into the wall or driven in at the appropriate point in the brickwork. Manufacturer’s gutter fascia bracket spacing requirements should be observed.
Once all fascia brackets have been installed, and working away from the running outlet, the gutter can be put into the fascia brackets and clipped into place by pulling the front of the gutter and the bracket downwards together. Make sure that the gutter is clipped into place at the back of the gutter first. The same method is used for making the gutter joints. Ensure the joint retaining clip is clipped properly over the gutter joints. This is shown in the drawing left. Do not insert the gutter beyond the expansion point in the fitting. Start at the joint on the running outlet and work away from that point.

- Ensure that the distance between joints is measured carefully, taking into account the expansion points.
- Remember to support cap ends with a fascia bracket no more than 150mm away from the end of the fitting.

AC5.4 Identify how to select brackets for rainwater pipework and space them at appropriate intervals

Installing rainwater pipes

<table>
<thead>
<tr>
<th>Pipe size (mm)</th>
<th>Vertical (m)</th>
<th>Horizontal (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 mm</td>
<td>1.2</td>
<td>0.6</td>
</tr>
<tr>
<td>62 mm</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>68 mm</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>70 mm</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>82 mm</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>110 mm</td>
<td>2.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

The swan neck is made from 2 x 122.5° bends that are joined together so that, once the swan neck is installed, the rainwater pipe is the correct pipe clip distance from the wall.

- Measure the distance between the spigot on the swan neck and the connection to drain and carefully cut a length of rainwater pipe to suit.
• Install the pipework and mark the position of the pipe clips, ensuring the correct pipe clip distances are used. These are shown in the table above.
• Choose the correct clip for the installation. There are several different pipe clip styles and these mostly depend on the manufacturer of the pipe. Some are more robust than others. It is possible to use pipe clips from other manufacturers, although there can be a variation in the colours. The sizes are the same, irrespective of the manufacturer.
• Drill the pipe clip holes using a suitable electric/cordless drill and drill bit.
• Fasten the rainwater pipe back to the wall using suitable plastic wall plugs and 50mm x 10 zinc plated screws.

AC5.5 Identify suitable methods for making new rainwater pipework connections to the drainage system

a. Rain water pipes can terminate over the top of a gully via a rainwater shoe
b. Direct connection to drainage bend using a suitable drain connector
c. Direct connection to gulley. The pipe must terminate below the grate but above the water line of the gully.
d. Direct connection to a soakaway. A typical soakaway is shown below

![Connection of a rainwater pipe to a soakaway drain](image)

AC5.6 Identify suitable methods for making new PVC-U pipework connections into existing rainwater pipework

On existing installations of gutters and rainwater pipes, where possible, all rainwater pipework should be replaced with new. However, there may be situations when new rainwater pipe must be connected to the existing rainwater installation.

a. **To existing cast iron pipework:** fittings are available to convert existing cast iron pipes to PVCu. These adapters are fitted over the open end spigot of cast iron pipe where new PVCu rainwater pipe is to
be installed **BELOW** the existing cast iron rain water pipe. The cast iron pipe fits inside the adapter. Where PVCu is to be installed above the cast iron pipe, then the PVCu may be inserted into a suitable cast iron socket and the joint completed using suitable silicone sealant or bitumen paint/putty.

**b. To existing PVC-U pipework:** in most cases, new PVCu pipe will fit existing PVCu rainwater pipes. The sizes are compatible.
Learning Outcome 7

Know the service and maintenance requirements of gravity rainwater systems
There are three Assessment Criteria to this Learning Outcome:

**AC7.1.** Identify how to carry out routine checks on gravity rainwater systems as part of a periodic maintenance programme

**AC7.2.** State the procedures for dealing with defects in gravity rainwater systems

**AC7.3.** Identify the procedures for safely handling gravity rainwater system components that may be contaminated with foul waste

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**AC7.1 Identify how to carry out routine checks on gravity rainwater systems as part of a periodic maintenance programme**

Conducting a visual inspection of a guttering system should be completed as part of an on-going maintenance programme. Some defects will be obvious at ground level, such as leaks, but others may need a closer inspection at height.

Remember when working at height to follow the correct health and safety procedures as detailed in [Section 1 – J/602/2479 Understand and carry out safe working practices in building services engineering, Learning Outcome 10 Know the methods of safely using access equipment in the building services industry.](#)

Faults to look for are listed below:

- Leaking joints
- Incorrect falls
- Blocked gutters
- Incorrectly clipped gutters and rainwater pipes
- Incorrect gutter type and size
- Vandalism and vehicle damage to rainwater pipes at ground level

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**AC7.2 State the procedures for dealing with defects in gravity rainwater systems**

- **Leaking joints** – these not only create more damage to the property but can be annoying. Leaking joints require rectification works. The method of rectification will depend on the type of gutter and the materials that they are made from
  - **PVCu** – most modern PVCu jointing systems use generic gutter and rainwater pipe sizes, especially for half round profiles. However, other profiles, such as square section and ogee are not always compatible. In many cases the manufacturers produce compatibility charts with other manufacturers to help guide the installer in choosing a viable alternative. Wherever possible, like-for-like fittings should be used. Older PVCu profiles are more difficult...
to assess, since the gutter and fittings may no longer be available. In these cases, it may require that the whole system be replaced with new.

In some instances, the joint may be repaired by replacing the defective rubber joint seal. These are usually available from plumbers merchants. Makeshift joints using silicon sealant should not be attempted because the joint will leak again as soon as thermal movement takes place.

- **Cast iron joints** – the joints themselves are usually quite easy to repair and involves removing the old gutter bolt, parting the joint and remaking the joint after cleaning the joint of the old jointing medium. Care should be exercised not to create too much movement as this may make other joints leak further down the run.

- **Incorrect falls** – again, incorrect falls will require work to be carried out to ensure that the water flows in the right direction towards the outlet. Back-falls often result in water spilling over the gutter creating property damage. Correcting the fall of a gutter will require the gutter being removed and the fascia brackets re-aligning with the correct fall.

- **Blocked gutters** – blocked gutters create two problems:
  - They cause water to overflow from the gutter
  - The add weight, which creates stress on the fascia brackets

Clearing blockages is an easy task to perform that prolongs the life of the gutter system. The gutter should be tested with water, once they have been cleared to assess that there are no underlying problems that are causing the blockages to appear in the fist place.

- **Incorrectly clipped gutters and rainwater pipes** – incorrectly spaced fascia brackets causes many problems with gutter systems. By not using the manufacturers correcting spacing recommendations, gutters begin to sag between the brackets, pulling the gutter out of the joints and creating leaks. Other damage is caused by wind and, because the gutter is not adequately clipped, excessive movement can cause the gutter to break. Rainwater pipes, too, suffer similar problems because of incorrect clip spacing.

Again, for fascia brackets to be correctly spaced, it may require the gutters to be removed and the fascia brackets re-aligned correctly.

- **Incorrect gutter type and size** – not an obvious problem as the gutter works adequately for the majority of the time. However, in periods of heavy rain, the gutter may overflow despite not showing any visible faults or defects. This usually becomes a problem after a building has had a major extension and the roof area has increased. The only way to be sure that the gutter size is correct is by taking measurements and performing the calculations shown earlier in the unit.

- **Vandalism and vehicle damage to rainwater pipes at ground level** – on public buildings, vandalism to rainwater pipes can be a major problem. In most cases PVCu is not strong enough to withstand a determined vandal attack and other, stronger materials should be considered as replacement.
AC7.3 Identify the procedures for safely handling gravity rainwater system components that may be contaminated with foul waste

Where rainwater system components come into contact with the foul drainage system, careful consideration must be given as to how we handle these components. Where possible, the following points should be observed:

- Human waste carries many diseases and handling components contaminated with human waste should be avoided where possible. Always where the correct PPE – the correct rubber gloves, eye protection and workwear. It may also be beneficial to consider using a face mask.
- Always have a bucket of hot soapy water available for washing down the equipment used and the PPE (gloves, goggles). Use disinfectant where necessary.
- Carry a well-stocked first aid kit that includes sterile wipes, and sterile waterproof adhesive dressings in case of injury.
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Learning Outcome 9

Know the inspection and testing requirements of gravity rainwater systems
There are three Assessment Criteria to this learning outcome:

**AC9.1.** State the checks to be carried out during a visual inspection of a gravity rainwater system to confirm that it is ready to receive rainwater.

**AC9.2.** State the test arrangements for gravity rainwater systems to check for leakage.

**AC9.3.** Identify the actions that must be taken when inspection and testing reveals defects in gravity rainwater systems.

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**AC9.1 State the checks to be carried out during a visual inspection of a gravity rainwater system to confirm that it is ready to receive rainwater**

When the gutters and rainwaters have been installed, a visual inspection should be carried out prior to testing:

- Check to make sure that the gutters are free of any debris left over from the installation process.
- Check both the gutters and rainwater pipes to ensure that they are adequately supported throughout the installation and that the manufacturers recommendations have been followed.
- Check that the fall of the gutter is adequate to clear the rainwater without pooling.

**AC9.2 State the test arrangements for gravity rainwater systems to check for leakage**

**Before testing**

Before testing takes place, the customer should be notified. If there is any personal customer property that may cause a hindrance to the testing and commissioning procedures, ask them move it to a safe location while the testing is completed.

**The testing procedure**

Testing should be completed using either a hose pipe or buckets of water. The water should be discharged on to the roof tiles at the gutters highest point(s) and not directly into the gutters as the latter can often splash over the gutters. Discharging the water on to the roof will cause the water to spread simulating rainfall. With the gutters in operation visually check that the water has a gentle flow towards the outlets and that pooling inside the gutter does not occur. Also check for any signs of joint leakage and that the water is discharging from the rainwater pipes in the correct location.
AC9.3 Identify the actions that must be taken when inspection and testing reveals defects in gravity rainwater systems

Sometimes, defective installation and components are revealed by the testing process. Any problems that do arise must be dealt with swiftly:

- **Dealing with systems that do not meet correct installation requirements** – poor installation is often the cause of problems with gutters and rainwater pipes. Problems such as too much fall, too little fall or no fall at all can cause major time concerns as the affected work must be taken down and reinstalled correctly. Sagging gutters too can cause aesthetic problems as well as performance related issues.

- **Remedial work associated with defective gutter and pipework bracketing** – as discussed earlier, insufficient fascia brackets and incorrectly placed pipe clips can cause gutter systems to fail in a relatively short space of time. Again, the affected work must be taken down and reinstalled correctly.

- **Remedial work associated with leakage from systems** – most leaks on new installations are caused by three very common issues:
  - Incorrectly jointed gutters
  - Defective components
  - Incorrectly positioned and jointed rainwater pipe fittings.

Of these three, incorrectly jointed gutters accounts for the vast majority of the problems encountered. This is usually due to incorrect measurements being taken and the gutter being cut too short for the gutter union or fitting. It is rare for gutter components to be supplied defective and when they are, most are due to missing sealing rubbers in the joints. Rainwater sockets and fittings are often fitted upside down with the socket facing downwards allowing water to run down the outside of the pipe. In all cases, the rectification is very simple to complete.