

Guide to the selection of UV disinfection systems for households

What is a private supply?

In general, a private water supply is any supply that is not provided by a water company. Most private supplies are situated in remote rural locations, fed by a well, borehole, spring, stream, lake, or similar. The supply may serve a single property, several properties, commercial or public premises.

All private water supplies must meet regulations¹ which include quality standards to ensure that the water is safe to drink.

The regulations are implemented by local authorities who are responsible for monitoring private supplies² through inspections ('risk assessments') and sampling, and will advise of the actions to be taken if a supply fails to meet the required standards.

What is UV disinfection?

UV disinfection inactivates harmful micro-organisms that could otherwise cause illness if consumed in drinking water. The micro-organisms in the water are exposed to UV light generated by a UV lamp enclosed in a stainless steel or (less commonly) plastic chamber. The UV lamp operates optimally at a temperature of about 40°C, and a quartz sleeve normally separates the lamp from the water to prevent the lamp from cooling.

A UV system rated to provide a dose of 40 mJ/cm² is recommended to achieve effective disinfection; the actual dose delivered will depend on water quality and flow rate.

Why is water quality important?

For UV disinfection to be effective, the water must be clear and relatively free from certain dissolved substances that may deposit on the quartz sleeve, reducing the amount of UV light reaching the harmful micro-organisms.

The clarity of water is usually expressed in terms of the amount of UV light that can pass - its 'Ultraviolet Transmittance' (UVT). Minimum UVT values, typically greater than 90-95%, are commonly specified by UV equipment manufacturers/suppliers.

¹ For England, The Private Water Supplies Regulations 2016. For Wales, The Private Water Supplies (Wales) Regulations 2010 (as amended). Available to download from:

<http://www.dwi.gov.uk/stakeholders/legislation/>

² A supply to a private single property is excluded from monitoring unless requested by the supply owner.

Dissolved substances that may deposit on the UV sleeve include colour, iron and manganese.

What should be included in a treatment system?

This depends on the quality of the source water and the presence of any contaminants. In general, a groundwater source (e.g. borehole) will be of better microbiological quality than a surface water source (e.g. stream or lake). Treatment before UV should be sufficient to ensure that the water being disinfected meets the required quality.

Treatment to remove common contaminants that might affect UV disinfection include:

- Suspended solids/turbidity – removed by filtration in replaceable cartridges, typically rated to remove particles larger than 5 µm, to around 1 NTU or lower.
- Colour - removed by activated carbon cartridges or membrane filters to around 20°H or lower.
- Iron and/or manganese – removed by oxidation and filtration in proprietary units to around 200 µg/l or 50 µg/l or lower, respectively.

How should the treatment system be operated and maintained?

All treatment units must be operated and maintained according to manufacturers'/suppliers' instructions. In particular, cartridges, filters and UV lamps must be replaced at recommended intervals. Maintenance is often modest but essential and annual contracts with specialist companies should be considered, particularly for more complex systems.

It is recommended that copies of manufacturers'/suppliers' operating and maintenance instructions be retained by the supply owner. In addition, a maintenance log should be maintained by the owner to record details of maintenance carried out and schedules for future maintenance.

UV disinfection equipment is compact and simple to operate. Most household units have little monitoring and control, often only a power on/off indicator and visual/audible alarms to indicate power or lamp failure. The units should be left switched on at all times and the operation of the lamp confirmed by regular and frequent observation.

Additional monitoring and control features are available, including UV intensity monitor, lamp run time, and automatic water shut off in the event of lamp or power failure. Such features are desirable, and should be considered where practicable as a way of providing some basic safeguards against consumption of disinfected water.

Similarly, validated systems are recognised as offering additional safeguards regarding confirmation of applied dose. It is recognised however that few validated systems are available in the sizes typically

used in private supplies. In all cases approved products designed for drinking water treatment should be used.

In the event of power or lamp failure, if the flow of water is not automatically interrupted, the drinking water produced will not be disinfected.

Can UV disinfected water be stored?

UV disinfection does not provide a long-lasting disinfectant residual. UV disinfected water for drinking or cooking should be supplied directly to an appropriate tap (usually the kitchen tap). Any water storage facilities must be hygienically maintained to ensure good quality, but should not supply drinking water.

Where can I obtain further information?

Further information can be obtained from:

- Your local authority.
- The Drinking Water Inspectorate (DWI) (<http://dwi.defra.gov.uk/private-water-supply/index.htm>)

For UV disinfection to be effective, the water must be of suitable quality and the applied UV dose must be sufficient. For these reasons, it is important that specialist advice is sought prior to the purchase and installation of a UV system, including any pre-treatment to remove contaminants such as suspended solids/turbidity, colour, iron or manganese.

The following checklists will help the householder to select a suitable UV system.

Information required to Specify and Test a Water Treatment System

Information required by a competent installer to specify and test a suitable water treatment system is listed below.

Q: What information is required about source water quality?
Maximum levels of turbidity, colour and other chemicals (e.g. iron and manganese) that might affect UV disinfection; microbiological quality (e.g. E. coli); seasonal variation in water quality (if any); likely increase or decrease in future water quality.
Q: What information is required about water flow and demand?
Average and peak demand; future changes to demand such as due to additional properties or change of use.
Q: What pre-treatment might be required?
This depends on the water quality: suspended solids/turbidity can be removed by filtration; colour can be removed by activated carbon or membrane filtration; iron and/or manganese can be removed by oxidation and filtration.
Q: How will treatment be proven to be effective?
Pre and post treatment water samples to be taken by the installer/local authority to verify effective treatment ¹ for all contaminants of concern, e.g. turbidity, colour, iron and manganese.
Q: How will I know if there is a problem with treatment?
Loss of flow or pressure if filters or media become blocked, possibly associated with discolouration and taste and odour problems; visual or audible alarms if UV lamp fails; UV lamp replacement indicator (light or counter) if lamp not replaced.

¹ Analysis should be carried out by a UKAS accredited laboratory.

Pre-treatment Options

Contaminant	Type of Pre-treatment	Comments
Particulate matter (turbidity, colour)	Particulate filter (cartridge)	Reduces turbidity and colour by filtration. Over time the filter will block and must be replaced when throughput is reduced or at intervals recommended by the manufacturer.
Colour	Activated carbon (cartridge)	Reduces colour by adsorption; will also reduce turbidity if not preceded by a particulate filter. Must be replaced at intervals recommended by the manufacturer. Bacterial growth may cause taste and odour if not changed frequently enough.
Iron / manganese	Iron / manganese filter	Dissolved iron and/or manganese is oxidised and removed in a filter. Typically supplied as a single proprietary unit including automatic backwashing of the filter.
Bacteria and other microorganisms	UV disinfection	Microorganisms are inactivated by UV light as water passes through the UV unit. May require upstream pre-treatment to remove turbidity, colour, iron and/or manganese. UV lamp must be replaced at intervals recommended by the manufacturer and quartz sleeve may require periodic cleaning.

Key Considerations when Purchasing a UV System

Water Quality
Water flowing to UV disinfection must be clear and relatively free from dissolved substances that may deposit on the quartz sleeve. Typical guide values: UVT >90%, turbidity <1 NTU, colour <20°H, iron <200 µg/l; manganese <50 µg/l. Values much higher than the guide values (lower for UVT) will require appropriate pre-treatment.
Flow Rate
The UV system should be sized for a maximum flow to satisfy the peak demand allowing for potential future increases. As a guide, typical water use per person is around 150 litres per day and kitchen taps typically discharge at 6-10 l/min (depending on pressure). UV systems are available for flow rates from 2 l/min upwards.

UV Dose
A design UV dose of 40 mJ/cm ² is recommended to achieve effective disinfection; actual dose is dependent on water quality and flow rate. Operating with poor quality water and/or at flow rates above the design value will compromise disinfection.
Monitoring and Control
Simple UV systems have little monitoring and control, often only a power on/off indicator and local visual/audible alarms to indicate power or lamp failure. More complex systems may include lamp hours run, UV intensity monitors, and automatic water shut off in the event of power or lamp failure or low UV intensity. Automatic water shut off prevents the flow of non-disinfected water.
Maintenance
UV systems must be maintained according to manufacturers'/suppliers' instructions. UV lamps must be replaced and quartz sleeves cleaned at recommended intervals. UV lamps are typically every 12 months, although frequent on-off operation will reduce the lamp life.