SECTION 12: DISTRIBUTION NETWORK AND RELATED MATTERS

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Section 12: Distribution network and related matters

Summary of Section 12

- Describes the importance of quality assurance systems including written procedures and training for all aspects of distribution networks operation.
- Describes the importance of risk assessment of the distribution network.
- Sets out some key features of distribution network operation including security and integrity of service reservoirs/water towers, risk assessment of failure/ contamination of the network, written procedures for operation of the network including risk assessments and method statements for major changes to network operations, use of approved chemicals and materials and regular maintenance of equipment.
- Describes the importance of written procedures to avoid contamination when installing new mains, repairing burst mains and re-lining existing mains including references to Codes of Practice for re-lining procedures.
- Sets out the importance of training of operators and gives some examples of available training courses.

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1. Introduction

1.1 | The water that leaves treatment works has been treated to remove impurities and to enable the standards and indicator parameter values in part 1 of the schedule to the Regulations to be met. However, it is important that the treated water does not deteriorate significantly within the distribution network before it is supplied to consumers. Water can become contaminated through ingress of environmental water into the distribution network, particularly if there are structural defects in service reservoirs and water towers or low pressures and bursts in the water mains in the network. Contamination can also occur through the use of inappropriate materials in contact with water in the distribution system.

1.2 | Private water suppliers should adopt a Quality Assurance Systems (QAS) approach (such as that advocated by the National Federation of Group Water Schemes, NFGWS) to the management, operation and maintenance of the distribution network. As part of a QAS, private water suppliers should have written operating and maintenance procedures (Standard Operating Procedures – SOPs) for the distribution network that aim to maintain the supply of water to consumers and that minimise the risk of contamination whilst the water is being distributed. The length of time the water is kept in the distribution network should be kept to a minimum taking into account the need to maintain a reserve of water in the network to meet peaks of demand. Managers and operators of private water supplies should be fully trained in each facet of the distribution network that they are expected to manage or operate.

2. Service reservoirs and water towers

2.1 | If a service reservoir or water tower (this includes storage tanks within the distribution network for small private water supplies) is not properly operated and maintained, it can present a serious risk of contamination. The following advice should assist private water supplier to avoid contamination of water in service reservoirs and, where appropriate, in water towers and storage tanks.

The service reservoir (or water tower/storage tank) site should be:

- secure from unauthorised access and ideally with an appropriate alarm system;
- as secure as possible from livestock (fenced) and other animals;
- secure from water run-off from the surrounding land; and

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- Secure from damage from nearby trees or other large plants.

2.2 | The structure of the service reservoir (or water tower/storage tank) should be kept in a good condition in particular there should be:

- no cracks in the floor, walls or the roof;
- adequate drainage for the roof with no place that external water could infiltrate into the reservoir, tower or tank;
- no signs of animal activity on the roof, covers on access hatches and other exposed parts of the reservoir, tower or tank;
- good seals on all access hatches and all holes in the structure for pipes, cables, sampling lines etc; and
- suitable mesh covers on all vents to prevent ingress of birds and small animals.

2.3 | The operating procedures for the service reservoir/water tower/storage tank, in particular for a reservoir/tower/tank with more than one compartment, should ensure that there is no accumulation of stagnant water and that the water is turned over as quickly as possible consistent with maintaining adequate reserves of water. It is equally important to ensure that the service reservoir/tower/tank does not run dry because, in addition to there being no supply of water, when the water supply is restored there are likely to be water quality problems through disturbance of deposits in the reservoir and downstream pipe work. The operating procedures should cover the setting of level probes and maintenance of probes including testing to make sure they are working properly.

2.4 | The private water supplier's procedures should include regular external inspection of the service reservoir/water tower/storage tank structure and the surrounding site. They should also include less frequent but regular internal inspection of the structure of the reservoir/tower/tank when the opportunity should be taken to remove any accumulated debris and to clean and disinfect the internal surfaces. Records of these inspections should be kept. Any defects identified during inspections should be rectified as quickly as possible and records of these actions kept.

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3. Operation and maintenance of the distribution network

3.1 | The private water supplier should have a **detailed map and schematic diagram** of the distribution network showing the location of each service reservoir, water tower and storage tank, each break pressure tank, all distribution mains, all valves including pressure reducing valves and all hydrants and washouts. Increasingly water suppliers are using GIS systems to record their distribution networks. It is also vitally important that private water suppliers know, and keep accurate records of, the status of all valves (closed, open, partially open), so that when changes need to be made to the operation of the network, the water travels in the direction intended.

3.2 | The private water supplier, particularly a Public Group Water Scheme (PuGWS) or Private Group Water Scheme (PrGWS) should carry out a **risk assessment of the distribution network** as part of a drinking water safety plan (DWSP) to determine whether there are any risks in the networks that are not controlled adequately and if there are to take appropriate action to reduce the risks. This risk assessment should include consideration of, for example:

- the security and integrity of service reservoirs and water towers;
- the length of time water remains in the service reservoirs/water towers and the network – time should be minimised to avoid deterioration of quality and "stale" water, but consistent with maintaining adequate supplies;
- what might happen if it is necessary to alter the distribution of water in the network, for example flow increases or flow reversals resulting in disturbance of any deposits in the networks causing discoloured water to be supplied to consumers;
- potential back-siphonage of contaminated water into the distribution network from industrial, commercial and domestic premises; and
- unauthorised or improper use of hydrants and washouts resulting in opportunities for direct contamination through the open hydrant or washout or indirect contamination through reduction in pressure in the network.

3.3 | Distribution networks inevitably contain some deposits arising from inadequate treatment in the past and from corrosion of the materials of the distribution network. These deposits tend to accumulate in low flow parts of the distribution network. If

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these deposits are disturbed consumers could be supplied with discoloured water containing particulate matter. Private water suppliers should have written procedures for the operation of the network that minimise the risk of disturbance of these deposits. Before a private water supplier makes any significant change to the operation of the distribution network (for many small private supplies there will be only one way to operate the network), it should carry out a **risk assessment** of the consequences of making that change on drinking water quality, particularly discoloured water. The risk assessment should lead to a **method statement** (for example the order of opening and closing valves and the rate at which they are opened and closed) in order to minimise any risk. These operational procedures should include for example:

- the way in which a new or stand-by treatment works is brought into supply to avoid surges in flow in distribution (increase the flow from the works slowly);
- the way in which the distribution network is managed to satisfy changes in demand to avoid sudden increases in flow and to avoid as far as possible flow reversals (moving of water from one area of the network to another by careful shutting and opening of appropriate valves);
- the way in which the distribution system is managed when it is necessary to change its operation to deal with for example internal inspection and repair of a service reservoir/water tower/storage tank, repair of burst mains and mains rehabilitation so as to avoid sudden increases in flow and to avoid as far as possible flow reversals; and
- maintaining adequate pressure within the system to avoid ingress of environmental water surrounding the water mains.

3.4 | Deterioration of water quality during distribution can also occur if the water remains in the distribution network for an excessive period of time. Typically the water can develop an offensive taste or odour when it becomes stale and has been in contact for a long time with the materials of the distribution system, any biofilms on the internal surfaces of the system and any deposits in the system. The private water supplier's procedures should include managing the distribution network in a way that minimises the time water is resident within the network or sections of the network.

3.5 | Automatic continuous chlorine monitors installed at the outlet of the service reservoir/water tower/tank and/or appropriate points in the distribution network with appropriate low chlorine warning and alarm limits can provide a useful guide on whether contamination may have entered the system.

3.6 | The procedures should also specify that only materials of construction that have been approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website (***http://dwi.gov.uk/31/approvedProducts.shtm***) (or equivalent approval system) should be used within the distribution network in contact with water and any conditions associated with the approval are met.

3.7 | The private water supplier should have procedures for the inspection of distribution networks (opening of hydrants to observe any deposits, observing the condition of mains when repairing bursts etc) as part of its criteria for deciding when maintenance is needed. Other criteria for determining when maintenance is needed should include the frequency of burst mains and the frequency of consumer complaints about drinking water quality, small animals in the water (ascellus, gammarus, chironamids, worms etc) or low water pressure. The private water supplier should have a programme of routine flushing of the network through wash-outs that concentrates on those parts of the network where deposits are known to accumulate. For those parts of the distribution network where there are regular difficulties that cannot be adequately controlled by flushing, the private water supplier will need a mains rehabilitation programme. This programme could include mechanical cleaning of mains, re-lining of mains and replacement of mains. Advice on the precautions to be taken when carrying out such programmes is given in sub-section 4 below.

4. New mains, repaired mains and re-lined mains

4.1 Introduction

4.1.1 | Whenever work is carried out on the distribution network that involves opening a main there is a risk of contamination during the process that could result in contamination of the water supply when the main is returned to service. Indeed many drinking water contamination incidents have been caused by water suppliers or their

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contractors failing to follow good practice and take adequate precautions during such work to minimise the risk. Such work could involve the installation of a new main, the repair of a burst in an existing main and the cleaning and re-lining of an existing main.

4.1.2 | It is recommended that the private water supplier has written procedures and instructions for carrying out these processes to ensure that there is no contamination during them. These procedures should include checking that the operators or contactors carrying out the work have followed the written procedures and instructions and that operators and contractors keep documented records of all actions taken within the distribution network.

4.1.3 | Frequently when these processes are carried out on the distribution network, there will be a need to discharge significant quantities of super-chlorinated water (water with higher than normal levels of chlorine used to disinfect the new, repaired or re-lined mains) or flushing water containing deposits from the cleaning process. Such chlorinated water may kill fish and other life if discharged to a water course and may interfere with the operation of sewage treatment works if discharged to a sewer or surface drain. Super-chlorinated water must not be discharged to a water course or to a surface drain that might lead to a water course without the consent of the local fisheries unit. It may be possible to discharge such water following de-chlorination. Similarly super-chlorinated water must not be discharged to a sewer or a surface drain leading to a sewage treatment works without the consent of the local authority. Flushing water containing deposits may deoxygenate or partially deoxygenate a water course or may interfere with sewage treatment processes and should not be discharged without the consent of the local fisheries unit or the local authority respectively. Any super-chlorinated or flushing water that cannot be discharged at the working site will need to be taken by tanker to a suitable disposal site.

4.2 Installation of new mains

4.2.1 | The following aspects are important for avoiding contamination during the installation and for ensuring that the drinking water quality standards are met once the main is brought into service and they should be included in the private water supplier's procedures:

- the mains are designed and sized carefully so that:

- they are large enough to meet the demand for water but not so large as to result in excessive residence time of water in the mains;
- dead ends and water stagnation are avoided, but if this is not possible adequate flushing points are provided;
- drainage of chambers for valves, meters, hydrants etc takes water away from the mains;
- air valves are at the highest point in the relevant parts of the distribution network; and
- the material of main in contact with the water is approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website ***http://dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system, pending the development of the European Acceptance Scheme) and is used in accordance with any approval conditions;

- following laying the mains must be cleaned and disinfected. As an example some suitable procedures are:
  - fill the mains with water containing 20 mg/l free chlorine;
  - flush the mains then refill with water containing 20 mg/l free chlorine and leaving in contact for 24 hours; and
  - displacing the chlorinated water with mains water and leaving for a further 24 hours pending the results of microbiological analysis;
- during and following the cleaning and disinfection process samples are taken and analysed as quickly as possible as follows:
  - free chlorine residuals to ensure that an adequate residual has been maintained throughout;
  - qualitative taste and odour of the displacement water to ensure that nothing offensive has leached before putting the main into supply;
  - visual appearance to check that all samples look satisfactory; and

- microbiological analysis, particularly coliforms, from a number of points along the mains including the extremities to check that all samples are free from coliforms **before the main is put into supply;**

- disinfection of the services connections if there is any doubt about their cleanliness;
- if all tests are satisfactory, careful introduction of the new mains into supply;
- a nominated person should be responsible for checking that everything has been carried out according to the procedures before giving permission for the new mains to be brought into supply.

4.3 Repair of burst mains

4.3.1 | The following aspects are important for avoiding contamination during the repair and for ensuring that the drinking water quality standards are met once the repaired main is brought back into service (in some circumstances a main can be repaired whilst still in service) and they should be included in the private water supplier's procedures.

4.3.2 | For repairs that involve cutting open the main these should include:

- that water should be kept out of the trench surrounding the repair; that special precautions are taken should there be any significant risk of pollution from for example sewage because of a nearby sewer;
- if practical, disinfecting the main in a similar manner to new mains but, for example, with a minimum contact period of 2 hours with 20 mg/l free chlorine or 30 minutes with 50 mg/l chlorine;
- if the above is not practical, disinfecting all surfaces that will come into contact with the treated water with a solution containing, for example, 1000 mg/l chlorine;
- after flushing, taking microbiological samples for coliforms;
- returning the main to service after flushing, provided there is no reason to suspect that contamination has entered the main (no need to wait for the results of microbiological samples);

- when there is reason to suspect that contamination may have entered the main, keeping the main out of service until the results of microbiological samples are available and are satisfactory;

- and making a nominated person responsible for checking that everything has been carried out according to the procedures before giving permission for the main to be returned into supply.

4.3.3 | For repairs that involve using a collar and keeping the main in service whilst the repair is made these should include:

- disinfecting the collar and the area of the fracture with a solution containing, for example, 1000 mg/l free chlorine; and

- taking a microbiological sample for coliforms to confirm that there was no contamination during the procedure.

4.4 Re-lining of existing mains

4.4.1 | There are a number of generic materials that can be used for re-lining existing mains to prolong their life. The most common ones are polyurethanes, epoxy resins, cement mortar and polyethylene or other type of plastics. The following aspects are important for avoiding contamination during the re-lining operation and for ensuring that the drinking water quality standards are met once the re-lined main is brought back into service and they should be included in the private water supplier's procedures. It is recognised that many private water suppliers are unlikely to use these techniques because it is probably more cost effective and practical to replace relatively short lengths of mains.

4.4.2 | For mains that are re-lined with polyurethane and epoxy resin materials particular care has to be taken to ensure that the components of these relining materials are thoroughly mixed in the correct proportions and that the applied mixture is adequately cured before the main is returned to service. The procedures should include:

- using only polyurethane and epoxy resin components that have been approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website ***http://dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system, pending the development of the European Acceptance Scheme) and is used in accordance with any approval conditions;

- using contractors that are competent to carry out the process. The contractors should apply these approved materials in accordance with strict operational requirements such as those documented in the UK Water Industry Information and Guidance Note IGN 4-02-2 "Code of Practice: In-situ resin lining of water mains" (***http://www.wis-ign.org/downloads/IGN%204-02-02.pdf***) and Water Industry Specification WIS 4-02-01 "Operational Requirements: In-situ resin lining of water mains" (***http://www.wis.ign.org/downloads/WIS%204-02-01.pdf***);

- that a nominated person in the private water supplier is responsible for supervising the contractor, checking that all procedures have been followed satisfactorily and giving permission for the re-lined main to be returned to supply.

4.4.3 | Generally cement mortar re-lining is suitable for large diameter mains because the residence time of the water is very short and there is unlikely to be significant leaching of the components of the cement. However, cement mortar re-lining is not suitable generally for other sizes of mains when the water to be supplied through the mains is soft, with say an alkalinity less than about 50 mg/l as calcium carbonate, because components of the cement are likely to be leached out to some extent causing high pH values. Cement mortar re-lining is suitable generally for other sizes of mains when the water is hard above about 50 mg/l as calcium carbonate. Particular care also has to be taken to ensure that the cement mortar is applied and cured properly before the main is returned to service. It is not possible to be specific about the sizes of mains because the suitability of a cement mortar product will depend primarily on the composition of the cement mortar, the size of the main and the alkalinity of the water. The procedures should include:

- using only cement mortar products that have been approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website ***http://dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system, pending the development of the European Acceptance Scheme) and is used in accordance with any approval conditions;

- using contractors that are competent to carry out the process. The contractors should apply these approved materials in accordance with strict operational requirements such as those documented in the Water Research Centre publication "In-situ cement mortar lining-Operational Guidelines and Codes of Practice", Water Research Centre plc,1990 (ISBN 0902156 84 5).

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5. Training of operators

5.1 | All operators should be trained in the processes that they are expected to operate within the distribution network. The training should include normal operation, identification of faults, how to rectify faults and how to react in incident and emergency situations. The operator should have a copy of the relevant distribution map showing the position of service reservoirs, water towers, distribution mains and all valves, hydrants and other equipment. The operator should have operating instructions for the relevant parts of the distribution system. A supervisor of the operator should review the operator's performance regularly and consider whether training needs to be up-dated. Records should be kept of operator training.

5.2 | All operators, maintenance staff and samplers (and any contractors and sub-contractors) working on the distribution network (including service reservoirs and water towers) where they could come into contact treated drinking water or come into contact with equipment that is in contact with drinking water, should have been **fully trained in hygienic practices** commensurate with their duties. Where appropriate, this training should include the actions required if one of these personnel has an illness (for example gastroenteritis or Hepatitis A) that could pose a risk of contamination of the drinking water supply or spread of the illness to other personnel. In the UK there is a national water hygiene training scheme that all operators and contractors are required to pass to obtain the "National Water Hygiene Card" before they can work on the distribution network. This scheme consists of completing a health questionnaire, receiving comprehensive water hygiene training and successfully passing a multi-choice test paper. The scheme is operated by Energy and Utility Skills Register (EUSR) on behalf of the UK water industry (***http://www.eusr.co.uk/eusr/the-eusr-card/the-national-water-hygiene-card***). The EPA recommends that WSAs develop, through the Water Services Training Group (WSTG), a hygiene training course for operators, contractors and others (such as samplers) working on water treatment works and distribution networks of private water suppliers.

5.3 | The Water Services Training Group (WSTG) has training programmes for distribution network operators and supervisors and details can be found at ***http://www.wsntg.ie/courses/courses.asp?id=all***. These include the following courses relevant to distribution operation (other suitable courses may be available from other training providers):

- Distribution system;

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- Leakage control;
- Location underground services; and
- Safety at excavation.

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