

SECTION 11: WATER TREATMENT AND RELATED MATTERS



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Section 11: Water treatment and related matters

Summary of Section 11

- ◆ Describes the importance of quality management systems including written procedures and training for all aspects of treatment works operation.
- ◆ Describes the importance of risk assessment of the catchment and raw water quality, the monitoring of raw water quality and the action to be taken if raw water quality deteriorates.
- ◆ Sets out some key features of treatment works operation including site security, risk assessment of failure of treatment processes, written procedures for operation of the processes including criteria for satisfactory performance, use of approved chemicals and materials and regular maintenance of equipment.
- ◆ Sets out the importance of training of operators and gives some examples of available training courses.
- ◆ Describes the importance of on-line monitors for the control of dosage of chemicals and for providing warning and alarm limits to detect deterioration in process performance.

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1. Introduction

1.1 | It is vital to ensuring drinking water quality that water treatment works are designed, operated and maintained properly. This means that Water Services Authorities (WSAs) should adopt a quality management systems approach, for example to the management, operation and maintenance of water treatment works. As part

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of a quality management system, WSAs should have written procedures (Standard Operating Procedures – SOPs) that set out how each part of the process and other related matters are to be operated and maintained at each treatment works so that the water leaving the treatment works meets the standards and other requirements of the Regulations. These procedures should include adjustments to processes when there are changes in circumstances such as deterioration of raw water quality and when abnormal circumstances exist. Managers and operators should be fully trained in each part of the process that they are expected to manage or operate.

1.2 | The Department of Environment, Heritage and Local Government (DoEHLG) has developed a Performance Management System (PMS) to assist WSAs as employers to manage the performance of private service providers in respect of Design, Build and Operation (DBO) and Operation Contracts. These contracts mainly concern the provision of private water supplies. The Water Services Training Group has issued comprehensive guidance to WSAs on these contracts (Volume 3 – Water Treatment Plant). No such guidance has been issued in respect of public water supplies. However, the DoEHLG and the Environment Protection Agency (EPA) consider that WSAs should take account of the principles of that guidance where it is relevant to WSA's operations on public water supplies.

1.3 | The Regulations require that a WSA takes all necessary measures to ensure that no substances (including any impurities in these substances) used in the treatment of water remain in concentrations higher than is necessary for the purpose of use and that they do not directly or indirectly reduce the protection of public health provided for in the Regulations. They also require a WSA to verify the efficiency of disinfection, when disinfection is practised, and ensure that the concentration of disinfection by-products is kept as low as possible without compromising disinfection.

1.4 | This section provides general guidance to WSAs on water treatment and related matters. More detailed guidance is provided in the following EPA Water Treatment Manuals, which can be freely downloaded from the web-site (<http://www.epa.ie>), and any subsequent up-date of these manuals:

- ◆ Filtration (1995);
- ◆ Disinfection (1998) (currently under review); and
- ◆ Coagulation, flocculation and clarification (2002).

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2. Raw water quality

2.1 | Raw water quality, particularly variations in raw water quality, for example following heavy rainfall, can have a significant effect on the performance of the treatment processes and hence compliance with the standards and indicator parameter values in part 1 of the schedule to the Regulations. It is important that each WSA monitors key parameters in the raw water so that appropriate action can be taken, for example adjustments to the operation of treatment to ensure the regulatory requirements are met.

2.2 | The WSA should have:

- ◆ carried out a risk assessment of the catchment, as part of a Drinking Water Safety Plan (DWSP) (see section 10 of this handbook), to determine whether there is a significant risk to the operation of the water treatment processes and the quality of drinking water supplies and to determine which parameters to monitor in the raw water. If there is a risk that cannot be dealt with by the treatment processes, the WSA must consider with the organisations responsible for the catchment whether any controls are possible or it must improve treatment;
- ◆ liaised with the EPA and other departments of the WSA to be informed of the results of any sampling and analysis they have carried out under the 1989 Regulations (S.I. 294 of 1989) or the 2003 Regulations (S.I. 722 of 2003) on the raw water;
- ◆ appropriate operational monitoring arrangements to ascertain raw water quality, including the parameters to be monitored and the frequency of monitoring. Whenever possible this should include continuous monitoring of key parameters, such as turbidity and conductivity, with appropriate alarm levels to give early warning of deteriorating raw water quality;
- ◆ appropriate treatment processes to treat the raw water, including all reasonably expected variations in raw water quality, to ensure compliance with the standards and indicator parameter values in part 1 of the schedule to the Regulations, to ensure the effectiveness of disinfection and to minimise the concentrations of disinfection by-products; and
- ◆ written criteria and arrangements for ceasing abstraction of raw water if its quality is such that the installed treatment processes are unlikely to be effective and therefore the treated water quality gives rise to, or is likely to give rise to, a

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potential danger to human health. If cessation of abstraction is not practical, the WSA must, in consultation and agreement with the Health Services Executive (the HSE), have other arrangements to protect consumers.

3. Water treatment works operation

3.1 | Each water treatment works site should be secure from unauthorised access. The level of security will depend on the location of the site (urban or rural etc) and a risk assessment of the location. The immediate surroundings of the site should not present a potential risk to the raw water arriving at the works or to the operation of the treatment processes (for example a nearby railway line or road). The site should not present a risk to nearby residents (for example should there be an accidental release of chlorine gas when used in the disinfection process).

3.2 | The WSA should have a detailed map of the water treatment works site showing clearly the location of each treatment process, including any sludge treatment, and the routes of the pipe work connecting each process and the location of ancillary equipment such as dosage systems, pumps valves etc. There should be a schematic diagram of each process showing the equipment, such as tanks, pumps and valves and chemical dosage systems, needed to operate the process. The diagram should also show the monitoring points to control each process.

3.3 | The WSA should carry out a risk assessment of the water treatment works, as part of a DWSP (see section 10 of this handbook), to determine whether there are any risks to the operation of the treatment processes that are not controlled adequately and, if there are, to take appropriate action to reduce the risks. This risk assessment should include consideration of:

- ◆ the effect of unexpected variations in raw water quality and what actions might be taken, for example adjustments to treatment such as increasing coagulant dose, reducing flow through the works, reducing intervals between filter backwash etc;
- ◆ the risks of failure of coagulation/clarification and what actions might be taken such as duplication of coagulation dosing systems (duty/standby), reducing flow through works etc;

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- ◆ the risks of failure of filtration and what actions might be taken for example regular inspection of filters for cracks, mud balls etc, reducing filtration rates and reducing backwashing intervals etc; and
- ◆ the risks of failure of the disinfection system and what actions might be taken such as duplication of disinfectant dosing systems (duty and standby), if practical automatic shut down of the works etc.

3.4 | The WSA should have a detailed procedure, as part of a quality management system, for the operation of each process, and each part of the process, that sets out what the operators should do in normal circumstances and how the operators should respond to unusual or abnormal circumstances. These procedures should be readily available to the operators at the site. As part of these procedures, there should be criteria that describe the satisfactory operation of each process, such as a physical or chemical measurement (continuous or intermittent monitoring). These criteria should include warning levels that indicate when the performance of a process is deteriorating and requires investigation and alarm levels that indicate when performance is unacceptable and urgent action needs to be taken. These procedures should set out the tests that the operators are expected to carry out and the frequency of those tests and the frequency that the operators should read or check process monitors. The unusual or abnormal circumstances may be a significant change in raw water quality, a problem with the operation of a particular process, a result from a process monitor that is outside the specified criteria, or a failure to meet a drinking water quality standard.

3.5 | Operators should keep an operational log of all action taken at the treatment works including, but not restricted to:

- ◆ all chemical dosage rates and the reason for any changes to dosage rates;
- ◆ all on-site measurements made by operator and routine readings of monitors;
- ◆ any other changes made to the operation of processes such as deliberate changes in flow rates;
- ◆ records of filter backwashes if initiated manually; and
- ◆ other relevant information relating to the processes at the site.

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3.6 | The WSA should have a detailed programme for the regular calibration of all dosage systems and monitoring equipment and a system for recording the results of calibration. The WSA should have detailed schedules for the maintenance, by WSA maintenance staff or by the manufacturers/suppliers, of all key items of process equipment, a system for ensuring that these schedules are met and a system for recording that maintenance has been carried out.

3.7 | The WSA should have robust procedures controlling the use of substances (chemicals), products and materials at treatment works including:

- ◆ that only products approved by the Drinking Water Inspectorate for England and Wales (list of approved products can be found on the DWI website (<http://www.dwi.gov.uk/31/approvedProducts.shtm>) (or other equivalent European approval system) are used and any conditions associated with the approval are met;
- ◆ that only products certified by an independent third party (approval body) as manufactured in accordance with the relevant European Standard are used;
- ◆ that purchasing departments should take into account the recommendations in the CEN Report "IS CR 14269:2001: Chemicals used for the treatment of water intended for human consumption – guidelines for purchase";
- ◆ that contractors are aware of the need to use approved products;
- ◆ that contracts for new treatment works or new equipment at existing treatment works specify that only approved products must be used;
- ◆ maintaining an up to date list of products approved by the Drinking Water Inspectorate for England and Wales (or other equivalent European approval system); and
- ◆ acceptance of deliveries to the site, labelling and security of the delivery point and checking the quality of deliveries against the specification.

4. Training of operators

4.1 | All operators should be fully trained in the processes that they are expected to operate. The training should include normal process operation, identification of faults in the process, how to rectify faults and how to react in emergency situations. Each

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operator should have a copy of the site map, the schematic diagrams of the processes at the works, the works operating manual and the operating instructions for the relevant processes. A supervisor of operators should review each operator's performance regularly and consider whether training needs to be up-dated. Full records should be kept of operator training including the training courses attended, the processes they are trained to operate and the dates of the training and any refresher training.

4.2 | All operators, maintenance staff and samplers (and any contractors and sub-contractors) working at the treatment works where they could come into contact with partially or fully 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. Hygienic practices are particularly important for multifunctional personnel who may work on both water supply and sewage. As an example, 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 a water treatment works (operation, repair and maintenance). 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.

4.3 | The WSTG has training programmes for water treatment works 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 water treatment works operation (other suitable courses may be available from other training providers):

- ◆ Chlorine handling;
- ◆ Filter operations;
- ◆ Fluoridation of water supplies;
- ◆ Water clarification and trihalomethane (THM) removal;

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- ◆ Water treatment dealing with problems;
- ◆ Water treatment plant maintenance;
- ◆ Water treatment revision programme;
- ◆ Water treatment programme; and
- ◆ Water conservation

5. Use of on-line monitors and control systems

5.1 | At some treatment works WSA use on-line monitors to measure raw water quality, to monitor and control individual processes and to monitor the final output of the works. With the encouragement of the EPA, WSAs generally have programmes to install monitors at treatment works, particularly to monitor and control individual treatment processes. Some examples of important on-line monitors and control systems are:

- ◆ continuous monitoring of turbidity and conductivity in the raw water to provide warning of deterioration of raw water quality so that action can be taken, such as to adjust treatment;
- ◆ discrete monitoring of aluminium or streaming current potential to monitor the performance of the coagulation/clarification process, so that adjustments to coagulation conditions (alum dose or pH value) can be made if performance deteriorates;
- ◆ continuous monitoring of turbidity of the filtrate from each individual filter so that attention can be given to filter integrity, operation or backwashing when elevated turbidity is found. Also there should be continuous monitoring of the combined filtrate from the filters;
- ◆ continuous monitoring of the pH value of the combined filtrate so that, if necessary an acid or alkali can be added to ensure that the pH value is optimised for effective disinfection; and

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- ◆ continuous monitoring of disinfectant residual (usually chlorine), to control the disinfectant dose and to ensure that an appropriate minimum chlorine residual is present in the water entering supply. At some treatment works continuous chlorine monitors are installed at more than one point such as after the chlorine contact tank and in the final water leaving the works after the treated water reservoir.

5.2 | It is important that the monitors and the control systems are properly set up and calibrated with appropriate control limits when controlling the dosage of chemicals, appropriate warning and alarm limits so that they adequately monitor the individual processes to detect deterioration in process performance and appropriate warning and alarm limits to detect deterioration of quality.

5.3 | The WSA should have written instructions for the operation of on-line monitors and the associated control systems that include:

- ◆ regular calibration of the monitor with an appropriate calibration range and recording of the results of calibration;
- ◆ setting of the control limits and the warning and alarm limits and regular review of those limits;
- ◆ regular testing of the control system to ensure it responds to out of control limits;
- ◆ regular testing of the alarm system to ensure that it is activated when the alarm limit is exceeded;
- ◆ when used to monitor and control key processes, there are back-up facilities in case of failure of the monitor or control system;
- ◆ arrangements to deal with power failures at the works or at the remote control centre;
- ◆ adequate arrangements for responding to alarms, including automatic cascade systems, whether locally or at a remote control centre including that:
 - alarms cannot be ignored or switched off or by-passed;
 - key alarms are clearly identified;
 - written procedures exist for responding to alarms and it is clear what each relevant member of staff is required to do; and

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- records are kept of all alarms and the action taken and the results of that action; and
- ◆ monitors, control systems and telemetry systems are maintained regularly by WSA staff or the manufacturers/suppliers and all maintenance carried out is recorded.