Drinking Water Inspectorate Guidance Document

GUIDANCE ON THE IMPLEMENTATION OF THE WATER SUPPLY (WATER QUALITY) REGULATIONS 2000 (as amended) IN ENGLAND

DOCUMENT CONTROL

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Errors and corrections:
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INTRODUCTION

1. Purpose of this document

1.1. This document provides guidance on the implementation of:

- the **Water Supply (Water Quality) Regulations 2000** (S.I. 2000/3184) as amended by
- the **Water Supply (Water Quality) Regulations 2000 (Amendment) Regulations 2007** (S.I. 2007/2734) and
- the **Water Supply Regulations 2010** (S.I. 2010/991)

which apply to water undertakers[1] and licensees whose areas of supply are wholly or mainly in England. The Inspectorate publishes a parallel guidance document relating to the Water Supply (Water Quality) Regulations 2010 (S.I. 2010/994 (W.99)) which apply to water undertakers and licensees whose areas of supply are wholly or mainly in Wales. Unless otherwise specified, reference within this document to "the Regulations" means the Water Supply (Water Quality) Regulations 2000 as amended. In line with common practice, water undertakers and licensees are referred to as water companies throughout this Guidance.

1.2. The Drinking Water Inspectorate (DWI) exercises the powers and duties of the Secretary of State for Environment, Food and Rural Affairs in England and Welsh Ministers in Wales. Therefore references to DWI or “the Inspectorate” in this document mean on behalf of the Secretary of State and/or Welsh Ministers as appropriate. References to the Secretary of State also include reference to Welsh Ministers and vice versa.

1.3. This guidance document published in September 2010 replaces the previous version of the guidance on the regulations published in October 2008. It does not purport to offer any authoritative interpretation of the Regulations. It is recognised that it may contain omissions and that some of the advice contained herein will need to be modified or updated in light of experience gained with implementing the Regulations or as and when further guidance on interpretation of the Drinking Water Directive is published by the European Commission.

1.4. The guidance is consistent with advice issued by DWI Information Letters up to and including 31 August 2010. However aspects may be updated or superseded by more recently issued letters so water companies would be wise to always check the DWI website for Information Letters issued after this guidance document. Comments are welcome on all aspects of the guidance. The master copy of the guidance document has been placed on the Drinking Water Inspectorate website (http://www.dwi.gov.uk) and only that version will receive any periodic updates. It is the intention to review the guidance on a rolling basis as and when the need arises. Water companies will be notified of any changes to the guidance by e-mail.

[1] For the purposes of this guidance document “Undertakers” also includes Inset Appointees.

2. The regulatory framework

2.1. The following legal instruments and associated documents provide the regulatory framework for the quality of drinking water supplies in England and Wales. Copies of all these documents are available on the Inspectorate's website.

2.2. **Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption (European Drinking Water Directive**) – sets standards for drinking water quality to apply in all member states, implemented in England and Wales through the drinking water regulations cited below.

2.3. **The Water Industry Act 1991** (the Act) – the primary legislation which enables Regulations to be made and contains the duties of water companies and the powers used by DWI.

2.4. **The Water Act 2003** – primary legislation which, *inter alia*, designates the post of Chief Inspector of Drinking Water, gives greater autonomy to the DWI and contains amended provisions in respect of fluoridation

2.5. Drinking Water Regulations applying to England:

- **The Water Supply (Water Quality) Regulations 2000** (SI 2000/3184)
- **The Water Supply (Water Quality) (Amendment) Regulations 2001** (SI 2001/2885)
- **The Water Supply (Water Quality)(Amendment) Regulations 2002** (SI 2002/2469)
- **The Water Supply (Water Quality)(Amendment) Regulations 2005** (SI 2005/2035)
- **The Water Supply (Water Quality) Regulations 2000 (Amendment) Regulations 2007** (SI 2007/2734)
- **The Water Supply Regulations 2010** (S.I. 2010/991).

2.6. Other legal instruments applying to England:

- **The Water Industry (Suppliers' Information) Direction 2009** – made under the Act, specifies the format and timing of water companies' provision of information to DWI.
- **The Drinking Water (Undertakings) (England and Wales) Regulations 2000** (SI 2000/1297) **as amended by the Water Supply (Miscellaneous Amendments) (England and Wales) Regulations 2010** (SI 2010/996) – relates to legally binding water quality improvement programmes to meet drinking water standards
- **The General Food Regulations 2004** (SI 2004 / 3279 as amended) and **Council Regulation 178/2002**.

- **Council Directive 98/34/EC The Technical Standards and Regulations Directive** - requires Member States to notify all new technical regulations when they are at the draft stage

- **Security and Emergency Measures (Water and Sewerage Undertakers) Direction 1998**

- **The Security and Emergency Measures (insert name of company) (Licensed Water Suppliers) Direction (insert year)** – this is a pro forma for a named licensee

- **The Security and Emergency Measures (Water Undertakers) Direction 2006** – this updates the 1998 Direction in light of Water Act 2003 and provisions for licensees

2.7. There are a wide range of other useful documents on the science and practice of drinking water quality regulation from research reports through to industry best practice documents. All of these may be of assistance to water companies. DWI makes many of these available through its website (www.dwi.gov.uk) either directly or by links to other websites. For example:

- The Water Supply (Water Quality) (England and Wales) Regulations 2000 SI No.3184 (Unofficial Consolidated version 2010) available on the DWI website. ***This unofficial consolidated version is provided for information only and has no legal status.***

- Drinking water safety - Guidance to health and water professionals - http://www.dwi.gov.uk/stakeholders/information-letters/2009/09_2009Annex.pdf

- World Health Organisation (WHO) Guidelines for drinking-water quality - http://www.who.int/water_sanitation_health/dwq/guidelines/en/index.html

- The Government's response to the consultation on the amendment of the Water Supply (Water Quality Regulations 2000 held between 29 December 2006 and 31 March 2007. *This document updates Government's policy on drinking water quality*.

PART I - GENERAL

3. Regulation 2(1) – Definition of Disinfection

3.1. The regulations define disinfection as "*a process of water treatment to remove or render harmless to human health every pathogenic micro-organism and pathogenic parasite that would otherwise be present in the water and 'disinfected' shall be construed accordingly*".

3.2. Disinfection, as defined, relates to the arrangements and equipment a water company has in place to treat raw water before it is supplied. These disinfection arrangements may be a single process of inactivation (such as chlorination, ultraviolet radiation, ozonation) or a single process of removal (such as membrane or other equivalent filtration technology) or it may be achieved through a combination of two or more removal or inactivation processes (such as filtration followed by UV and chlorination). It is important therefore that the technical performance characteristics of the disinfection arrangements used by the water company at each of its water treatment works is known in relation to the ability of the process or combined processes (when operated in the manner intended) to remove or inactivate pathogens, and that these performance characteristics are validated in advance. Performance characteristics of disinfection arrangements should be validated against the removal and/or inactivation of pathogens. The validation of performance characteristics of disinfection arrangements shall not be defined in terms of removal or inactivation of indicator organisms such as coliforms or *Escherichia coli* (*E.coli)* or enterococci. These indicator organisms, as defined in the regulations are not pathogens. Indicator organisms are however appropriate for use in the verification of disinfection arrangements.

3.3. The technical performance of disinfection arrangements should target the widest possible range of pathogens – viruses, bacteria, parasites and toxic algae – that are likely to occur in the source(s) of water being abstracted for water supply purposes and are recognised by the Health Protection Agency as potential agents of waterborne disease. It is expected that a water company will have in place a disinfection policy which is informed by sound science and by knowledge of the occurrence of pathogens in water sources in England and Wales. The disinfection policy will cover the design, maintenance and operation of all relevant components of its treatment works. See also guidance on regulation 26.

PART II – WATER SUPPLY ZONES

4. Regulation 3 - Delineation and designation of water supply zones

4.1. Regulation 3(1) requires water companies to pre-designate the names and areas of the supply zones within its supply area for the forthcoming calendar year. Regulation 3(2) specifies that the water supply zone should not supply more than 100,000 people and regulation 3(3) requires that the designation of the water supply zone should not change through the year.

4.2. In the last quarter of each calendar year, water companies should review the designation of their water supply zones to ensure that the delineation remains appropriate and assess revised estimated populations. The population estimates for water supply zones should relate to permanent residents only. During the review, water companies should identify any water supply zone where the revised estimate of resident population supplied exceeds 100,000. Regulations 3(2) and 3(3) provide that the delineation of such zones should be revised to produce zones with a population below 100,000 in the following year. In general the number of changes to the designation of water supply zones should be kept to a minimum.

4.3. A consistent approach is needed in the delineation of water supply zones. Water companies should therefore first identify which areas are supplied from single sources. A source could be the outlet of a water treatment works, a pumping station, a blending point, a service reservoir or a meter point on a bulk supply of treated water provided by another water company. A discrete area supplied from a single source should always be recorded as a single water supply zone unless it supplies more than 100,000 people. In such circumstances the area should be subdivided into water supply zones each with a population of less than 100,000.

4.4. Regulation 3 (2A) requires that water quality within a supply zone should be approximately uniform. This requirement will be met if a zone is served only by a single source as set out above. However the Inspectorate recognises that the actual supply arrangements may be more complicated and the following paragraphs are intended to assist in the interpretation of this requirement.

4.5. The requirement that water quality is approximately uniform, will be met if:

- each supply zone is served by an individual service reservoir or water tower, pumping or booster station or distinguished as a discrete pressure zone or by other appropriate features of the distribution system;
- where there is more than one source of water, these are of a similar nature and receive the same treatment;

4.6. If there are or could be significant differences in water quality within any discrete area of supply then this area should be sub-divided into separate supply zones. In areas where the potential for variations in water quality are complex or where the water supplied may be from a number of potential sources via transfer mains, the water supply zone should be delineated by reference to convenient features of the distribution system and geography.

4.7. Many water companies have delineated their supply areas into district metered areas which under normal operation have a single supply inlet. In such circumstances water supply zones should consist of related district metered areas, which are supplied from common sources.

4.8. It is recognised that water companies have to take temporary operational actions to maintain water supplies that may involve the introduction of water from sources not designated for that supply zone. Such temporary measures should not influence the annual designation of water supply zones. If permanent changes have to be made to the sources that supply a zone, or to the delineation of that zone, the designation of the zone can only be changed for the next calendar year.

4.9. Where water companies provide a concessionary (free) supply of water to consumers, for domestic purposes, for example supplies to a single dwelling or a small number of co-located dwellings in a rural area that originate as a consequence of an historic agreement with a landowner, then these are subject to the requirements of the Water Supply (Water Quality) Regulations 2000 (as amended). All such supplies in a company's operational area, wherever they are located geographically, should be grouped together in a single water supply zone on the basis that such supplies have similar characteristics (surface water or springs with minimal or no treatment). Information Letter 05/2008 provides detailed guidance on companies' responsibilities regarding concessionary supplies.

4.10. Some companies have designated a number of water supply zones which are very small (population <5000). These usually serve a discrete rural community. Water companies are encouraged to review small water supply zones with a view to combining them together into a larger water supply zone (under regulation 3(2A)). Typical examples might be:

- where there are several small ground water sources each serving a separate village but all drawing water from the same stable aquifer and all being subject to the same type of water treatment.
- a set of zones each served by a different treated water reservoir but all receiving water from the same large treatment works.

4.11. Where the designation of small zones is changed then companies must specify and keep a record of the relationship between the previous zone designations and the new ones.

PART III - WHOLESOMENESS

5. Regulations 4(1) & 4(2) – Wholesomeness

5.1. Under section 68 of the Water Industry Act 1991 water companies are under a statutory duty to supply wholesome water.

5.2. Whenever a water company provides a water supply to consumers for cooking, drinking, food preparation and washing, or to premises for food production purposes then this must meet the wholesomeness requirements of the regulations regardless of whether this is via a piped supply system, tanker, bottle or other container.

5.3. Regulation 4 provides that water is wholesome if it contains concentrations or values in respect of various properties, elements, organisms and substances that do not contravene the prescribed maximum, and in some cases, minimum concentrations or value (PCV). Some of the PCVs are specified in regulation 4 but most are included in Tables A and B in Schedule 1 of the Regulations.

5.4. Attention is also drawn to regulation 4(2) which covers the situation where water supplied contains micro-organisms, parasites and substances for which no standard has been set. Companies should familiarise themselves with specific guidance issued by the Inspectorate on particular substances which is freely available on the DWI website (Guidance & codes of practice) and also take into consideration expert opinion on drinking water safety such as that published in the World Health Organisation (WHO) Guidelines for Drinking-water quality and independent medical advice.

5.5. Companies are also reminded of their obligations under regulation 10 with respect of further sampling arrangements for substances that may result in water being unwholesome.

6. Regulations 4(3) to 4(6) – Point of compliance

6.1. Regulation 4(3) states that various standards for wholesomeness are to be complied with at the consumer's tap except in the case of water supplied from a tanker or by means of bottles or containers where the point of compliance is specified respectively.

Tankers

6.2. The point of compliance for tankers is defined as the point at which water first emerges from the tanker. Requirements for the frequency of sampling from tankers are contained within regulations 6(3) and 6(4).

Bottles and containers

6.3. The point of compliance for bottles and containers is defined as the point at which water first emerges from any bottle or container. The definition of the point of compliance relates only to bottles or containers which have been stored by the water company at a temporary local public distribution point, it does not relate to stocks of bottles or containers which are under the control and management of the producer, the company or any specialist supplier.

6.4. The regulations do not specify monitoring requirements for water supplied by means of bottles or containers. However water companies are reminded of their duties under the Water Industry Act 1991 to supply water that is wholesome and fit for human consumption. The Inspectorate considers that as a fundamental aspect of due diligence water companies should develop appropriate quality control procedures for supplies provided in bottles and containers. These arrangements should cover the entire supply chain and include consideration of the risks posed by unattended distribution points. The Inspectorate encourages companies to work together with their suppliers to identify and document best practice and to promote its adoption across England & Wales. The Inspectorate considers that companies are under a duty to secure that such quality control arrangements are in place and carry out audits of their effectiveness.

Consumers' taps

6.5. The Regulations implement European Directive 98/83/EC on the quality of water intended for human consumption. The Directive's standards must be complied with, in the case of water supplied from a distribution network, at the point within premises or an establishment, at which it emerges from the taps that are normally used for human consumption. Water companies are not responsible for any deterioration in water quality that may arise as a result of the domestic distribution system with the exception of plumbing metals copper and lead where specific regulations apply, and certain duties in relation to remedial action in buildings where water is made available to the public (see regulation 19A).

6.6. Part IV of the Regulations requires monitoring at sampling points and other points to establish whether the water supplied meets the standards for wholesomeness. A sampling point is defined in regulation 2 as being a consumer's tap that is selected for monitoring purposes. From 1 January 2005, all water companies were advised to select from all premises and establishments (including public buildings) within their area of supply in their random compliance monitoring programmes for water supply zones.

6.7. The consumer's tap is not defined in the Regulations. Water companies should assume that the consumers' taps to be used for monitoring to determine compliance with the standards are those taps that are normally used for drinking, cooking, food preparation or other domestic purposes. In a domestic property this tap is normally the kitchen cold water tap that is used for drinking and food preparation purposes irrespective of whether any upstream devices such as softeners or filters are present. Garden taps should not be used for regulatory samples. In non-domestic properties (including public buildings) the sampler should seek to determine from the occupier or owner which tap is normally used for drinking and food preparation (or supply to the public in the case of public buildings) and should sample from that tap. Where more than one appropriate tap is available in a building, the sampler will need to record accurately which tap was sampled.

6.8. Since it is known that upstream "point of use" devices and/or the nature of the tap can influence the quality of water, it is good practice for these details to be recorded by the sampler at the time of sampling to assist the interpretation of any adverse results obtained from analysis of the sample in the laboratory. Alternatively, if prior to collection of the sample, the sampler becomes aware that an upstream device is present or there are unusual fittings on the tap which cannot be removed to facilitate tap cleansing, then they can select another nearby property to be sampled for

compliance purposes. However, in these circumstances, samples must still be taken from the original property and arrangements made for appropriate advice to be given to the owner/occupier, including, as appropriate, a water fittings inspection. Companies must document their protocols and keep records of every non-compliance sample generated in this way.

6.9. It has long been established practice to "disinfect" the sample tap before sampling for microbiological parameters. Indeed, cleansing of the cold water tap is recommended prior to sampling for bacteriological parameters by the Microbiology of Drinking Water. It should be noted that "disinfecting" of taps is a generic term to describe a process of cleansing the tap which involves the application of chlorine based solution as a spray or in the form of a proprietary wipe to the outlet followed by running the tap to waste. Companies are advised that the act of flushing to draw off standing water is a very important part of the cleansing protocol and this must be emphasised to samplers in their training. As many domestic taps are made from plastics the application of heat to the tap is no longer used. Until such time as any more specific advice is provided through a revision of the Drinking Water Directive companies may continue to follow best practice as set out in the Microbiology of Drinking Water.

6.10. The Directive requirement for water in public buildings is for it to meet the quality requirements irrespective of whether or not any non-compliance is due to the domestic distribution system or the maintenance thereof. It is for this reason that in previous versions of this guidance the Drinking Water Inspectorate advised that taps in public buildings should not be cleansed prior to sampling for microbiological parameters. However in light of advice of the EU working group on sampling and monitoring who recommended that taps are disinfected for all compliance samples taken under the Directive, companies should apply the same sampling method to taps in public buildings as they do to taps in domestic premises.

Water treatment works

6.11. Regulation 4(4) defines the criteria for wholesomeness on transfer from a water treatment works. Regulation 13(1) requires water companies to ensure that samples for *E.coli*, coliform bacteria, colony counts, residual disinfectant, turbidity and nitrite are taken at the required frequency from the point at which water leaves each treatment works.

6.12. The sampling point should be located so as to provide a representative sample of the water flowing into distribution. The sample point must be downstream of all treatment processes including blending and any storage in final water storage reservoirs at the treatment works.

6.13. Where the treatment stream within a works divides in such a way that a single final water compliance point will not be representative of all water leaving the works (i.e. there are different treatment streams which leave the works through different outlet mains), then more than one sampling point will be required. Where there is a possibility of differences in water quality within different outlet mains leaving the treatment works then separate sampling points are required for each outlet main. Although on the same site, each treatment stream is regarded as a separate water treatment works for the purposes of the Regulations.

6.14. All treatment works outlets should be fitted with metal sampling taps of a hygienic design which do not have attachments or inserts. Appropriate metal taps approved by

WRAS are suitable for treatment works installations. Water should be supplied to the sampling tap through a sampling line of suitable material, which if plastic should be a WRAS approved material. Sample lines should be kept as short as possible and the number of take offs from the sample line should be kept to a minimum.

6.15. WRAS approved materials and fittings will have been tested to BS6920 specifications and are assured not to give rise to adverse impact on the microbial, chemical and aesthetic quality of the water. The WRAS Directory can be accessed at www.wras.co.uk.

Service reservoirs

6.16. Regulation 4(5) defines the criteria for wholesomeness on transfer from a service reservoir. Regulation 14 requires water companies to ensure that a sample is taken for bacteriological analysis and determination of residual disinfectant in each week the reservoir is in use. Water Companies should be confident that samples taken are representative of the water from each service reservoir.

6.17. The Regulations define a service reservoir as any structure in which a reserve of treated water is contained and stored for the purposes of meeting a variable demand for the supply of water. The definition specifically excludes any structure at a water treatment works such as final water storage reservoirs. Sampling points at service reservoirs should be located so as to provide a representative sample of the water flowing into distribution.

6.18. The definition includes any temporary structures such as static tanks or tankers that are connected to the distribution system and are being used as service reservoirs. Accordingly, water from these structures should be sampled every week they are in use.

6.19. Break pressure tanks should not be designated as service reservoirs unless they are designed to provide strategic water storage. There is always a risk of ingress where the system is vented and companies are encouraged to conduct operational monitoring at break pressure tanks that do not provide strategic storage. Some water companies have water retaining structures which are solely connected to further service reservoirs and do not supply consumers directly via distribution mains. If such water retaining structures contain strategic reserves of water they should be classified as service reservoirs and sampled within the compliance monitoring programme.

6.20. Where a service reservoir has more than one compartment with its own water inlet and outlet and the compartments are not connected hydraulically to any other compartments, then each compartment should be regarded as a single service reservoir. Sampling is required at the outlet main of each compartment unless the individual outlets subsequently combine into a single common outlet main.

6.21. Where a service reservoir has more than one compartment but the compartments are hydraulically connected then the connected compartments may collectively be regarded as a single service reservoir and be sampled accordingly.

6.22. Where a service reservoir has a single main that serves as a common inlet and outlet, the water company must have arrangements to ensure that samples are taken only when the main is acting as an outlet and the water quality is therefore representative of water that has been stored within the service reservoir. Where this is not practicable alternative representative sampling arrangements can be made.

6.23. All sampling points should be fitted with metal sampling taps of a hygienic design which do not have attachments or inserts. Appropriate metal taps approved by WRAS are suitable for service reservoir installations. Water should be supplied to the sampling tap through a sampling line of suitable material, which if plastic should be a WRAS approved material. Sample lines should be kept as short as possible and the number of take offs from the sample line should be kept to a minimum.

6.24. WRAS approved materials and fittings will have been tested to BS6920 specifications and are assured not to give rise to adverse impact on the microbial, chemical and aesthetic quality of the water. The WRAS Directory can be accessed at www.wras.co.uk.

Other sampling arrangements at water treatment works and service reservoirs

6.25. It is not possible for this guidance document to describe all the possible arrangements for the siting of regulatory sampling points at water treatment works and service reservoirs. Where water companies are unsure about the number or siting of regulatory sampling points they should submit details of their proposals to the Inspectorate for approval.

Bulk supplies

6.26. Water companies may receive inputs of treated water from neighbouring water companies termed as “bulk supplies”. Such supplies should not be monitored as water leaving a treatment works within the compliance sampling programme (as this will be undertaken by the water company which operates the supplying treatment works). It would however be prudent to undertake water quality monitoring of such supplies at the point of transfer on an operational basis. The bulk supply input point may be an appropriate location for authorised supply point monitoring if this monitoring option is being used by the water company receiving the bulk supply. Companies should ensure they have adequate arrangements in place for the operation of bulk supply points such that appropriate monitoring occurs and communication procedures are in place to share information on treatment or quality problems, adverse results and water quality events in a timely manner.

PART IV – MONITORING OF WATER SUPPLIES

7. Regulation 6(1) – Monitoring: numbers of samples

7.1. Regulation 6(1) states that water companies shall take and analyse not less than the number of samples specified within the provisions of Part IV. A water company may programme and report more than the minimum number specified for any parameter to ensure that the minimum sampling and analysis requirement is met.

7.2. It is recognised that water companies will wish to carry out some additional sampling to provide additional information on the quality of water supplies. Water companies may prefer to manage such monitoring within a separate non-compliance sampling programme with individual samples identified by a separate sample purpose code.

7.3. Water companies may carry out sampling for both compliance and non-compliance purposes on the same sampling occasion provided that the samples taken are identified by separate unique sample numbers or other auditable process (with the appropriate sample reason).

7.4. If water companies wish to carry out additional sampling within the regulatory monitoring programme they should not programme significantly above the numbers specified for selected parameters in order to influence compliance statistics.

8. Regulation 6(2) – check and audit monitoring

8.1. Regulation 6(2), with reference to Table1 of Schedule 3, sets out the criteria under which parameters should be monitored at check or audit frequency. These are:

i. Parameters listed in Table 1 that have no conditions specified must be monitored at check frequency;

ii. Parameters that are listed in the Table 1 and with conditions specified in column 3 of the Table must be monitored at audit frequency, unless the conditions are met when they must be monitored at check frequency; and

iii. Parameters <u>not</u> listed in the Table 1 must be monitored at audit frequency.

8.2. The relevant frequencies are specified in Table 2 for water supply zones and Table 3 for supply points. The Water Supply Regulations 2010 update the format of these tables to aid clarity but do not change the monitoring requirements.

8.3. In practice this means that there are six parameters which can **either** be monitored at check monitoring frequency **or** at audit monitoring frequency depending on the following circumstances:

i. **aluminium** and **iron** are to be monitored at the lower audit monitoring frequency unless they are used as a flocculant or coagulant at the treatment works or the water originates from, or is influenced, by surface waters in

which case the higher check monitoring frequency applies. The frequencies are specified in Table 2 of Schedule 3;

ii. **manganese** is to be monitored at the lower audit monitoring frequency unless the water originates from or is influenced by surface waters, in which case the higher check monitoring frequency applies. The frequencies are specified in Table 2 of Schedule 3;

iii. water companies should consider undertaking additional operational monitoring at groundwater sources which have significant natural concentrations of iron and/or manganese;

iv. ***Clostridium perfringens*** is a Schedule 2 indicator parameter which should be monitored at treatment works or supply points at the audit monitoring frequency unless the water originates from or is influenced by surface waters, in which case the higher check monitoring frequency applies.
The Inspectorate does not consider the monitoring of *Clostridium perfringens* at consumer's taps to be consistent with the primary role of these organisms as an indicator of remote or historic faecal contamination which has its greatest use as an indicator of the adequacy of the operation of water treatment. Accordingly companies are advised not to routinely include this parameter in water supply zone compliance monitoring.
The sampling frequency required by the Directive (and transposed into the Regulations) for large treatment works can be as high as 2,190 samples per annum, which would necessitate taking multiple samples each day from large works. The Inspectorate considers that this is neither practical nor desirable and therefore where the required sampling frequency exceeds 365 samples per annum companies are advised to take at least 365 samples from the appropriate treatment works. The remaining samples required to the meet the minimum frequency may be taken from supply points, service reservoirs, or where no practical alternative exists, in water supply zones.
Where samples are taken from a treatment works then the results should be reported against the supply point site code in the monthly data return to DWI as described in Information Letter 2/2005.

Regardless of the sampling location, it is **imperative** that a company's response to an unsatisfactory result includes a comprehensive investigation into the efficacy and performance of the treatment process of the supplying works.

It should be noted that testing in zones for *Clostridium perfringens* has merits as an investigational tool and should continue to be used when following up failures for *E.coli* or enterococci at service reservoirs and consumer's taps.

v. **nitrite** and **nitrate** are to be monitored in water supply zones at the lower audit monitoring frequency unless chloramination is practised at the water treatment works, when the higher check monitoring frequency applies in the water supply zones. The frequencies are specified in Table 2 of Schedule 3. In addition there is a requirement to monitor for nitrite at the water treatment works, against the 0.1 mg/l standard. Nitrite is to be monitored at the water treatment works at the lower monitoring frequency (item 4 of Table 3) unless chloramination is practised, in which case the higher monitoring frequency specified at item 16 in Table 3 applies.

9. Regulation 6(2) - Monitoring of pesticides

9.1. The Regulations set the following standards for pesticides and related products:

- aldrin 0.03 µg/ l
  dieldrin 0.03 µg/ l
  heptachlor 0.03 µg/ l
  heptachlor epoxide 0.03 µg/ l
- other pesticides 0.10 µg/ l
- total pesticides 0.50 µg/ l

Pesticides and related products are defined as any organic insecticide, herbicide, fungicide, nematocide, acaricide, algicide, rodenticide, slimicide, molluscicide and any product related to any of these including any growth regulator, and their *relevant* metabolites, degradation and reaction products. *Relevant* should be taken to mean any metabolites, degradation and reaction products that have similar pesticidal properties to their parent pesticides. No guidance has yet been issued by the European Commission[2] but until it is, the Inspectorate considers that, in respect of drinking water, there is no evidence at the present time that any pesticide metabolites, degradation or reaction products are active pesticides or represent a risk to health and therefore no additional monitoring is required. Research published in 2010 confirms that this approach remains appropriate for pesticide metabolites in England and Wales (http://www.dwi.gov.uk/research/index.htm).

9.2. The standard for other pesticides applies to each individual pesticide, also including any relevant metabolite, degradation and reaction product. Total pesticides means the sum of the detected concentrations of the individual pesticides and any relevant metabolites, degradation and reaction products detected and quantified in the samples taken on a particular sampling occasion from a sampling point. This definition recognises that more than one sample may be taken on a particular sampling occasion from a sampling point to enable all the pesticides of interest to be determined.

9.3. It is not practical or necessary to monitor for every pesticide that is used within the catchment of a water source. The Drinking Water Directive recognises this by noting that only those pesticides which are likely to be present in a given supply need be monitored. To effectively implement the requirements of the Drinking Water Directive, each water company is required to develop a monitoring strategy for pesticides. On the basis of that strategy, the treated water leaving each treatment works (or supply point) should be monitored at the frequency specified in Table 3 of Schedule 3 of the Regulations.

9.4. Companies should fully utilise the information gathered in the preparation and review of their regulatory risk assessments and raw water monitoring programmes (under regulation 16A) in formulating any monitoring programme for pesticides in treated water.

[2] This guidance document will be updated in the light of any forthcoming Commission guidance on the definition or interpretation of related products and relevant metabolites, degradation and reaction products as it may apply to the European Drinking Water Directive

9.5. As part of the catchment element of their regulatory risk assessment companies are expected to:

i. assess as far as is practicable which pesticides are used in significant amounts within the catchment area of each water source;

ii. assess as far as is practicable on the basis of the properties and method of use of these pesticides, and local catchment knowledge, whether any of these pesticides are likely to reach each water source in the catchment area;

iii. take into account the results of any monitoring for pesticides in water sources within the catchment area carried out by the Environment Agency or other organisations;

iv. take into account the results of any regulatory or operational monitoring of water sources or water supplies for pesticides carried out previously by the water company

9.6. The regulatory risk assessment will provide the basis for a company's regulatory raw water monitoring programme and operational monitoring of water sources and *vice versa*.

9.7. The majority of pesticide monitoring should take place in the raw water to inform companies' statutory risk assessments and to assess the need for treated water pesticide monitoring. Companies are expected to determine which pesticides should be monitored in the treated drinking water based on their assessments of risks in the catchment, the results of raw water monitoring, and the control measures they have in place to mitigate elevated levels of pesticides in water sources. Where, based on this assessment, they have reason to believe that a pesticide is likely to be present in the treated water then this pesticide should be included in their treated water monitoring programme.

9.8. Companies are expected to monitor pesticide levels in the treated drinking water for any pesticide which it identifies as a residual risk in its regulatory risk assessment.

9.9. Where the company has evidence that a pesticide is absent from monitoring in a raw water source for a period of 3 continuous years (at a monitoring frequency not less than that required by the regulations) then this pesticide should no longer be monitored in the treated water. Monitoring should continue in the raw water depending on the assessment of risk in the catchment.

9.10. Where a treatment works has a process installed to remove pesticides or reduce the concentration of pesticides the company's risk assessment should identify the target pesticides and these should be monitored in both the raw and treated waters. Where the company has evidence that a target pesticide is absent from the treated water for a period of 3 continuous years (at a monitoring frequency not less than that required by the regulations) then this pesticide should no longer be monitored in the treated water. Monitoring should continue in the raw water depending on the assessment of risk in the catchment.

9.11. If at any time a water company has any reasonable grounds for believing that a pesticide not included in its monitoring strategy for a particular works could be present in treated water at a concentration in excess of the standard, it must assess the levels of that pesticide in its raw water source as soon as possible to validate the presence of

any risk (or otherwise). The company should update its risk assessment and treated water monitoring strategy accordingly.

9.12. It is expected that companies monitoring strategy for pesticides will be reviewed, particularly for any new and emerging pesticides and related products, and kept up to date as part of the regulatory risk assessment process.

9.13. The standards for pesticides apply at consumers' taps. However, regulation 8(1) allows water companies to monitor compliance with those standards by taking samples for pesticides from supply points because the results of the analysis of such samples are unlikely to differ in any material respect from the results of the analysis of samples taken from consumers' taps. Should water companies choose to monitor at customer taps in water supply zones, then they should develop their strategies based on the source or sources that supply particular zones and the considerations given above. Sampling frequencies for zones are given in Schedule 3 Table 2. Water companies receiving small bulk supplies from other companies may use the originating company's pesticide monitoring data for that supply (i.e. the point of bulk supply is used a supply point for pesticide monitoring purposes).

10. Regulation 6(3) - Monitoring: Sampling - tankers

10.1. Regulation 6(3) requires water companies to take samples from water tankers in specified circumstances. Within England and Wales water is not normally distributed by tanker except on occasion for short term supplies associated with operational work or emergency provisions. The regulations do not specify monitoring requirements for water supplied by means of bottles or containers.

10.2. Regulation 6(3) does not apply to the use of tankers to fill service reservoirs. Water companies should follow good operational practice for filling tankers and transporting water to service reservoirs and weekly regulatory monitoring must continue at the service reservoir being supplied by tanker.

10.3. For the purposes of these Regulations water tankers are considered as any mobile water tank used to provide water supplies to consumers on a temporary basis and includes water bowsers and static tanks. Water tankers should only be filled with wholesome water from a known source and companies should ensure they have in place appropriate arrangements for the cleaning, disinfection and storage of tankers.

10.4. The Regulations require monitoring for *E.coli*, hydrogen ion and conductivity from each tanker that has been providing water for longer than 48 hours. Any tanker that has been providing water continuously for more than 96 hours must be sampled and analysed for full microbiological and chemical analysis. Further samples for full microbiological and chemical analysis must be taken after every additional 48 hours of use of the tanker. If tankers are collected or emptied before an initial 48 hour period has elapsed there is no monitoring requirement. A tanker should only be filled and re-filled with wholesome water.

10.5. In order to demonstrate that they have complied with these requirements water companies should keep detailed records of the deployment of each tanker. These records should include the material of the construction of the tanker or a reference that allows this to be determined, its cleaning, the source of the water used to fill it, the time of filling, the time of emptying, the time of refilling and the source of the water used to refill it. Not only will these records allow companies to demonstrate they have complied

with the 48 hour and 96 hour sampling requirements specified in the Regulations, they will also provide valuable information necessary for the investigation of any failures that may occur. Where tankers that are not dedicated to the use of wholesome drinking water are employed, the water company must have in place documented evidence of appropriate cleaning, disinfection and sampling.

11. Regulation 6(6) – Monitoring of copper, lead and nickel

11.1. The Regulations require sampling of water supplies at the consumer's tap for copper, lead and nickel at the audit frequency specified in Table 2 of Schedule 3. Samples for these parameters must always be taken at consumers' taps. The sampling point should be selected from the random sampling programme and the sample should be the first one litre of water drawn from the tap without flushing.

12. Regulation 6(7) – Radioactivity monitoring

12.1. The monitoring of radioactivity is complex. Therefore although elevated levels of radioactivity are rare, the paragraphs below provide guidance on determining monitoring requirements for radioactivity and on the response to results of this monitoring. This is also summarised in the various flowcharts in Appendix 2.

12.2. The Regulations require sampling of water supplies for the determination of radioactivity. Sampling is to be undertaken at audit frequency specified in Table 2 or Table 3 of Schedule 3. Analysis is required for tritium as an individual radionuclide, which is effectively a screening parameter for the presence of contamination by artificial radionuclides. Monitoring for total indicative dose (TID) is routinely achieved by analysis for gross alpha and gross beta activities although it is calculated from the activities of individual radionuclides using the summation formula given in Appendix 2.

12.3. Calculation of TID is only required if the screening values for gross alpha, gross beta or tritium are exceeded. In many water supplies the gross beta activity is primarily due to the presence of potassium-40, a naturally occurring radioactive isotope of potassium. As potassium-40 is specifically excluded from the calculation of total indicative dose, it may be helpful to monitor for potassium alongside any monitoring for gross alpha and gross beta activity. [Note: For each mg/l of potassium, the beta activity due to potassium-40 is 0.03026Bq/l].

12.4. Regulation 6(7) permits the Secretary of State (in practice DWI) to issue a notice to a water company permitting them not to monitor for radiological parameters where he is satisfied that the water supply is well below the specification for the relevant parameters. In the absence of a specific regulation 6(7) notice companies must monitor for radiological parameters based on the advice set out below. This guidance is based on expert advice from radiological specialists in the Health Protection Agency (HPA), the full version of which is available on the research section of the Inspectorate's website (here).

Stage 1: Initial screening

12.5. The water industry in the UK is already well-equipped to carry out measurements of gross alpha and beta activity, whereas the capability for radionuclide-specific analyses is much more limited. The equipment needed for the determination of specific radionuclides is expensive and requires dedicated experienced staff. The industry is required to carry out extensive monitoring on a range of potential contaminants and given that the majority of samples conform to the criteria on gross activity expert advice is that a move to a system based on radionuclide-specific analyses is not warranted.

12.6. Sources of raw water in England and Wales are more likely to be affected by naturally-occurring alpha emitting radionuclides such as ^{234}U, ^{238}U or ^{226}Ra than other forms of radioactivity. However, many radionuclides that might be found in water supplies emit beta particles. Examples are the naturally occurring radionuclides ^{40}K, ^{210}Pb and ^{210}Bi, (all of which are excluded from the estimation of TID under the Drinking Water Directive), and artificial radionuclides such as ^{60}Co (cobalt-60), ^{90}Sr (strontium-90) and ^{137}Cs (caesium-137). Strontium-90 and, to a much lesser extent, ^{137}Cs have been detected in sources of raw drinking water in England and Wales however the observed concentrations are very small, well below the criterion on gross beta activity of 1 Bq l^{-1}. The gross beta activity tends to be dominated by ^{40}K. In addition, many of the radionuclides that might be released in nuclear reactor accidents or from incidents involving industrial sources emit beta particles. Measurements of gross beta activity can be useful in such circumstances, since they may remove the need for more radionuclide-specific analyses. It is important therefore that, as gross beta activity may also be present in raw waters, companies should ensure that they consider both gross alpha and gross beta screening values.

12.7. Unless a company has received a Notice under regulation 6(7) in respect of TID it must monitor at its supply points (or in its zones) for gross alpha and gross beta at the relevant audit frequency. The flow charts and associated notes in appendix 2 provide guidance on monitoring for gross-alpha, gross-beta and TID, including the need for statutory monitoring of TID. The flowcharts attempt to deal with a variety of circumstances but do not attempt to specify the form of any more detailed analysis. This must be judged on a case by case basis. The flow charts do not apply to monitoring for tritium.

12.8. Where methods for removing radionuclides from drinking water have been introduced to ensure that a parametric indicator value is not exceeded, companies shall monitor at the audit frequency

12.9. Water companies should use screening methods for gross alpha activity and gross beta activity to monitor for the parametric indicator value for TID. If the gross alpha and the gross beta are less than 0.1Bq/l and 1.0Bq/l respectively, the water company may assume that the TID is less than the parametric indicator value of 0.1mSv/year and no further radiological investigation is needed. If the gross alpha activity exceeds 0.1Bq/l or the gross beta activity exceeds 1.0 Bq/l, analysis for specific radionuclides shall be required. The radionuclides to be measured shall be defined by taking into account all relevant information about likely sources of radioactivity. Where necessary, tritium, gross alpha activity and gross beta activity may be measured in the same sample.

12.10. The criterion for TID relates to an annual dose, and so if the criteria on gross activity are only exceeded for a short time then this does not necessarily imply that the TID will be exceeded. Therefore if the screening criterion for either gross alpha (0.1Bq/l) or gross beta (1.0Bq/l) activity is exceeded, companies are advised to first check the validity of the result. It may be possible to use the data from other samples analysed in the same batch to demonstrate that the procedure and the measurement equipment itself are working properly. Checks on instrument calibration and background would also be needed. If a sufficient amount of the original sample is available, then a repeat analysis should be carried out.

12.11. Once the validity of the initial measurement data have been established, companies should collect further samples from the relevant supply and carry out further measurements of gross activity. A reasonable amount of data is needed quickly in order to assess the situation. As the time between collecting the original sample and having the analytical data could be up to a few days it would be prudent to collect a further sample before any checks on the original sample were completed. Samples should therefore be taken every few days and not less than once per week. Companies should ensure that their laboratory or analytical service provider has the capability to increase sample throughput in such a way, albeit for a relatively short period. However, if the gross activity concentrations fell below the criteria then it might not be necessary to carry out analyses on all of the samples that have been collected. Companies may also consider using historical monitoring data to help inform this stage where the likely hazards/sources are known to be unchanged from the time of the previous monitoring.

12.12. If the criteria for gross activity continue to be exceeded, then radionuclide-specific analyses will be needed. Companies should therefore ensure that a sufficient volume of sample is collected each time so that if necessary these types of analysis can be carried out later.

12.13. TID relates to an annual dose and concentrations of radionuclides will need to remain elevated over that sort of period if the dose value is to be exceeded. If measurements taken over a period of about 4 weeks fell below the criteria for gross alpha and / or beta, then no intervention would be needed to reduce doses to members of the public. Some occasional sampling might still be needed to provide reassurance that the low concentrations have not increased. If the measured gross concentrations remained in excess of the criteria over a period of around 4 weeks, then sampling should continue on at least a weekly basis, depending on the concentrations being found. At this stage consideration would also need to be given to more specific analyses, as described below.

Stage 2: Further screening

12.14. Where monitoring shows the gross alpha and/or gross beta screening values are exceeded on multiple occasions over a period of time (e.g. a month) then companies should conduct screening for specific radionuclides.

12.15. A comprehensive determination of all radionuclides is neither practicable nor desirable. Companies should therefore develop a radionuclide-specific monitoring strategy. This section outlines how the radionuclides of interest can be selected and how to develop an analytical strategy.

12.16. Companies should ensure that they take into account all relevant information when deciding on the radionuclides to be studied. This should take account of other monitoring data within the area of interest i.e. the catchment from which the raw water is abstracted. For example:

- There are various sites across the UK that are licensed to discharge small quantities of radioactivity into the environment. These include the nuclear fuel reprocessing plant at Sellafield, nuclear power stations and radiopharmaceutical facilities. The site operators are required to undertake environmental monitoring, and independent programmes are also carried out by government agencies;
- Monitoring also takes place around some landfill sites;
- More general nationwide programmes dealing with diet, milk and water are also in operation.

The most comprehensive source of monitoring data is that issued annually by a consortium consisting of the Environment Agency, the Food Standards Agency, the Scottish Environment Protection Agency and the Northern Ireland Environment Agency. The report is given the acronym RIFE (Radioactivity in Food and the Environment). This gives data for national surveys of milk, drinking water and some foodstuffs, as well as information generated by these agencies from around specific sites. Some data on discharges are also included. Further environmental monitoring data may be available from site operators or from local authorities which can also be used to decide whether the analysis of a particular radionuclide is warranted.

12.17. In terms of **gross alpha activity**, isotopes of uranium and radium are most likely to account for exceedances. Unless there is specific information to the contrary these radionuclides should be determined first together with ^{210}Po. Polonium-210 is a radon decay product and so strictly should not be included in the estimation of TID. However, it may be present in water sources and would contribute to the gross alpha activity. Artificial alpha emitting radionuclides such as plutonium-239 and -240 (^{239,240}Pu) and americium-241 (^{241}Am) generally become strongly sorbed on to soil or sediment and so would not then be expected to be found in sources of drinking water[3].

12.18. Many of the radionuclides that emit **beta particles** also emit gamma photons. The energy of these photons characterises the radionuclide. Consequently, when the criterion on gross beta activity is exceeded, high-resolution gamma-ray spectrometry provides a powerful way of determining the presence or absence of a wide range of both natural and artificial radionuclides. Potassium-40 emits a characteristic gamma photon, and so the radionuclide most likely to account for exceedance of the criterion on gross beta can be determined very conveniently. There are other radionuclides of potential importance, notably ^{90}Sr, that do not emit gamma photons, for which radiochemical isolation would be needed.

12.19. The results of this “stage 2” screening, such as high-resolution gamma-ray spectrometry should be assessed in consultation with radiological and health protection experts to determine whether further more detailed monitoring and determination of the Total Indicative Dose is required.

[3] In the case of an incident involving the accidental or deliberate discharge of such radionuclides directly into the drinking water supply, water companies might reasonably expect information on the radionuclides involved to come from other organisations.

Stage 3: Assessment of nuclide-specific results and determination of Total Indicative Dose (TID)

12.20. The significance of results from nuclide-specific analysis can be assessed by comparison to reference concentrations. Reference concentrations provide a useful input to radiological assessments because they are related to a primary criterion based on dose, in this case the TID of 0.1 mSv y^{-1}. They are expressed in terms of activity concentrations in drinking water and so can be compared directly with measured values. They represent the activity concentration of a specific radionuclide that, when taken with a consumption rate of 2 litres per day, would give a dose of 0.1 mSv. Actual doses from the consumption of drinking water containing these concentrations are likely to be less than the 0.1 mSv criterion

12.21. Table 1 in appendix 2 gives reference concentrations for a range of radionuclides that might be encountered in the environment in the UK (based on RIFE monitoring, annual drinking water consumption and dose coefficients published by the International Commission on Radiological Protection (ICRP). Note - the presence of a radionuclide in the Table does ***not*** imply that all water companies must carry out an analysis for that specific radionuclide. That choice needs to be made on the basis of the available information for the catchment in question, as set out above.

12.22. Reference concentrations have also been derived for ^{210}Pb and ^{210}Po. These radionuclides are part of the chain of radon decay products and so strictly would be excluded from any estimation of TID. However, they are determined routinely in various monitoring programmes and may make contributions to the overall gross activities in a sample of drinking water. Reference concentrations for these radionuclides are therefore provided to help to put the measured values in context.

12.23. By this stage, radionuclide specific data should be available for samples collected over a period of weeks. It would be appropriate to consider the mean values over the sampling period rather than the maxima observed as the presence of elevated activity concentrations remaining over considerable periods of time is of key significance.

12.24. The overall radiological impact can be evaluated through the calculation set out in note 6 to flowchart 3 in the appendix. **If the sum of the quotients is less than 1, then there is no need for further action.**

Action required if the reference concentrations are exceeded

12.25. Some of the detection limits needed for the monitoring system proposed here are low in environmental terms and require considerable analytical expertise. If the measurements made on a particular sample indicate that the criterion on TID of 0.1 mSv per year might be exceeded, then the actions that should be undertaken are similar to those given earlier for exceedances in the criteria for gross activity. These actions are set out below.

- Check that the sample has been taken from the supply point. If it has not, then collect a further sample from the correct location and repeat the analysis. An evaluation of the TID should normally relate to water from a supply point.

- Carry out checks on instrument calibration and background if these have not been done recently; examine data for samples that were analysed at the same time but which have come from other locations; examine data on any reagent blanks that have been analysed at the same time. Together, these data will provide information on whether there are any problems with the overall analytical procedure.

- If there is sufficient sample left, carry out another analysis for those radionuclides that contribute most to the exceedance of the TID. This will determine whether or not there was anything unusual about the first analysis. It would be helpful to analyse a reagent blank alongside this repeat sample to evaluate whether any cross-contamination had taken place.
- Collect a further sample from the location of interest, ensuring that sufficient volume is collected so that repeat analyses can be carried out if necessary. For many radionuclides, it is likely that this second sample can be collected a few days after the first. However, there are some radionuclides for which the analyses can take several days or weeks. In these cases, it would be worthwhile taking several samples at intervals of a few days, so that data on temporal changes can be monitored. Depending on the results, it may not be necessary to analyse all of these samples.

12.26. This part of the investigation process should establish whether there is an ongoing problem. Sustained increases, particularly of artificial radionuclides, should prompt a further investigation including liaison with other monitoring organisations and the Environment Agency.

12.27. If activity concentrations remain elevated, then sampling needs to continue on a regular basis with a minimum frequency of one or two samples per month. A higher frequency might be needed, depending on the activity concentrations and the resultant estimated doses. The measurement data should be kept under continual review to inform any decisions to reduce the sampling frequency. This increased monitoring effort should enable the water company to decide whether the annual dose criterion of 0.1 mSv is being exceeded.

Action require if the Total Indicative Dose (TID) is exceeded

12.28. The Drinking Water Directive requires action to be taken if the evidence clearly indicates that an annual dose of 0.1 mSv is being exceeded. The actual dose received by a consumer will vary depending on tap water consumption rates and age group. Once it becomes clear that the criterion on TID has been exceeded, companies should assess the potential impact on adults, children and infants based on annual consumption rates given here and dose coefficients. Expert radiological protection advice should be sought at this point.

12.29. HPA advice is that the indicator specification of 0.1 mSv provides a significant level of safety in relation to potential impact on public health and is many orders of magnitude below that which would be needed to cause short term observable health effects. For comparison, the annual dose that an average person the in the UK receives from all sources of natural radiation is estimated at about 2.2 mSv. The principal annual dose limit for members of the public recommended by ICRP, which relates to doses arising only from controlled releases into the environment, is 1 mSv. The value of 1 mSv y^{-1} is itself set well below any level at which there is a risk to public health.

12.30. HPA advice is that although action to reduce activity concentrations in drinking water should be considered it need not be implemented urgently if the criterion on TID has only been marginally exceeded. The types of action to be considered will depend on the specific circumstances and should be taken in consultation with radiological protection experts (in particular the Health Protection Agency's Radiological Protection Division). Some information on the practicalities of various courses of action has been published in the context of recovery after accidents and incidents (see HPA Recovery Handbook).

Radioactivity – Analytical methods

12.31. As the reference concentrations in Table 1 in appendix 2 are related directly to the TID, in order to be of use in the radiological assessment process proposed here, any analytical detection limits would need to be much less than the corresponding reference concentration so as not to have an undue influence over the calculated result. Therefore for radioanalytical methods to be of use to water companies, the detection limit should be below 20% of the relevant reference concentration. Water companies should ensure that detection limits are agreed in advance with the analysing laboratory.

12.32. Guidance on the selection of the most appropriate analytical techniques for the radionuclides listed in Table 1 is given in section 5 of the full HPA document available on the DWI website.

Reporting exceedances of gross-alpha and gross-beta screening values

12.33. The exceedance of the gross alpha and gross screening values does not necessarily constitute a failure of the regulatory standard for Total Indicative Dose (TID). The process outlined within this guidance has a number of stages that will determine if the standard for TID has been contravened. When reporting an exceedence of the screening values it is important that companies include in the supporting report, the stages of investigation that were carried out to ascertain if a TID contravention has occurred.

Monitoring for tritium

12.34. Monitoring of drinking water for tritium is necessary where a source of tritium is present within the catchment and it cannot be shown on the basis of other surveillance programmes or investigations that the level of tritium is well below its parametric indicator value 100Bq/l. Where monitoring for tritium is required, it must be carried out at the audit frequency.

12.35. Tritium was included in the Drinking Water Directive on the basis that it provides an indication of other, potentially more harmful, artificial radionuclides discharged into the environment. In the UK such discharges are subject to stringent controls and even where authorised discharges of artificial alpha and beta emitters occurs within the water catchment the concentrations of tritium are low and routinely below 10Bq/l.

12.36. In these circumstances monitoring of tritium in drinking water would be a check on on-going discharges of radioactivity to the environment. Environmental sampling

programmes already exist tailored to sample close to the source of discharges. Elevated concentrations of tritium have also been associated with landfill leachates where the tritium probably derives from the disposal of gaseous tritium lighting devices and is not an indicator of other artificial radionuclides. In these cases elevated gross beta activity has also been detected in the water, probably due to the presence of particulates and natural potassium-40. The relationship between tritium and landfill sites is best investigated by research projects rather than routine monitoring.

Regulation 6(7) – notice to cease radioactivity monitoring

12.37. The only exemption to the statutory monitoring requirements outlined above is where a water company has received a notice under regulation 6(7) from the Inspectorate indicating that tritium and/or total indicative dose need not be monitored.

12.38. Companies that consider they have sufficient information to demonstrate that total indicative dose is well below the specification may apply for a Notice under regulation 6(7) to reduce or cease statutory monitoring for radioactivity parameters. Applications must include the name of the treatment works or supply point for which the notice is requested, a summary of the likely presence of natural or artificial sources of radioactivity within the catchment, results of all radioactivity monitoring for gross alpha, gross beta and tritium conducted at the works or supply point, together with results of and further radiological investigations conducted in response to values in excess of the specifications

12.39. The Inspectorate will assess any applications made and for those where there is sufficient evidence that the levels are well below the specification, will issue notices for tritium and/or total indicative dose as the case may be. Notices are currently time limited (5 years). Applications for renewal should be accompanied by an appropriate risk assessment and verification data to show that a notice is still appropriate.

12.40. As indicated in Information Letter 01/2005 the Inspectorate will only normally issue notices under regulation 6(7) that start on 1 January of a calendar year. Therefore, should a company request a notice valid from 1 January of any future year, the application should be made by 30 November of the year prior to which the notice takes effect.

12.41. The Inspectorate may withdraw a notice under regulation 6(7) if they are no longer satisfied that the parameter(s) concerned are no longer well below the specification set out in the regulations.

12.42. If companies receive a notice under regulation 6(7) allowing them not to monitor for radioactivity, they are strongly advised to establish an operational monitoring programme. Should a sample taken under the operational monitoring programme fail to meet the specification, the Company must investigate and notify the Inspectorate of the outcome of the investigation, in accordance with regulation 18.

13. Regulation 7 – Sampling points (random selection)

13.1. Regulation 7 requires all sampling points in water supply zones to be selected at random except in relation to those parameters where monitoring from supply points has been authorised. Water companies are expected to use a sampling programme that selects sample points at random from a comprehensive list of its consumers, including public buildings.

13.2. Water companies' methods should ensure random selection from a customer list to produce an individual target address or a sampling location such as a designated street or a designated postcode. If a sample cannot be obtained from the target sample address a neighbouring property should be chosen and appropriate records amended accordingly. A check should always be made to ensure that any alternative address is within the target water supply zone, especially when properties are close to the water supply zone boundaries.

13.3. The Inspectorate expects water companies to be able to obtain samples from randomly selected sample points in most circumstances. In exceptional circumstances water companies may apply to the Inspectorate to use an alternative method of selection for sample points. An example of such circumstances is concessionary water supplies.

13.4. Companies should ensure that their random sampling programme includes all premises and establishments within their area of supply – i.e. including premises where water is made available to the public ("public buildings"). They should also ensure that the results of these samples are appropriately flagged (with a 'PB' identifier) in their compliance data returns to the Inspectorate.

13.5. The Inspectorate is aware that some water companies have concerns regarding the security of samplers in some specific locations. Where a water company considers that these concerns prevent the implementation of sampling by random selection of sample points it should provide the Inspectorate with evidence of the risk e.g. a letter from the police or local authority and information on its alternative method for selecting appropriate samples. The Inspectorate will indicate whether or not the alternative method is acceptable.

13.6. Regulation 19A places certain requirements on the Inspectorate to ensure companies take remedial action in certain circumstances where the failure is attributable to the domestic distribution systems of buildings where water is made available to the public. Further guidance on regulation 19A is given in later sections of this document.

13.7. In the event of a widespread event which may affect water companies' ability to collect samples from randomly selected sample points – e.g. access restrictions due to an animal disease outbreak, or extreme weather events, the Inspectorate will issue specific guidance relating to that event.

14. Regulation 8 – Authorisation of supply points

14.1. The Drinking Water Directive permits the use of monitoring at supply points for parameters provided it can be demonstrated that there would be "no adverse change to the measured value" for the parameter between the supply point and the consumers' taps. Under regulation 8(1) the Secretary of State automatically authorises the use of certain supply points for certain parameters. Under regulation 8(2) the Secretary of State has discretion to authorise supply points for other parameters, subject to certain criteria.

14.2. At any supply point, water companies should ensure that sample points are fitted with metal sampling taps of a hygienic design which do not have attachments or inserts and which are made from materials complying with BS6920. They should be fitted in such a way as to ensure that the sample is representative of the water in the main.

14.3. When treatment works or service reservoirs are used as supply points they must be coded as supply points in the monthly data returns for applicable parameters, e.g. for C. perfringens.

Regulation 8(1) Automatically authorised supply points

14.4. Regulation 8(1) authorises the use of supply points for monitoring the following parameters:

- *Clostridium perfringens*; conductivity; benzene; boron; bromate; cyanide; 1,2-dichloroethane; fluoride; mercury; pesticides and related parameters; trichloroethene and trichloroethane; tetrachloromethane; chloride; sulphate; total organic carbon; tritium; gross alpha and gross beta.

14.5. Supply points authorised in the context of regulation 8(1) may be:

- treatment works
- service reservoirs (prior to supply to customers)
- blending points

14.6. A blending point means a point at which treated waters, originating from two or more sources, are combined under controlled conditions. In practice, blending is normally accomplished by the controlled mixing of treated waters in service reservoirs and specific sections of trunk main. The position of any sample tap at a blending point, used as a supply point, should be carefully selected to ensure that adequate mixing has taken place prior to the sample tap.

14.7. For any supply point used under regulation 8(1) the company should be satisfied that there is no subsequent significant change in the value or concentration of the parameters between the supply point and consumer's taps. Regulation 1A prohibits the use of supply points where a combined licensee introduces water into the water supply zone unless the water quality within the water supply zone remains approximately uniform. The Inspectorate expects combined licensees to obtain and make available sufficient data to allow the water company (in advance of any introduction of water) to determine whether existing supply point monitoring can continue. The Inspectorate must be notified as soon as possible and applications for

authorisations in these circumstances should follow the general approach which is already in place in respect of authorisations under regulation 8(2).

14.8. Companies should apply the relevant monitoring frequencies in Table 3 of Schedule 3 and should remain on supply point monitoring for a full calendar year.

14.9. The Regulations make no reference to the provision of a bulk supply of water from one water company to another, though this is common practice. For the parameters specified above and subject to prior approval of the Inspectorate, companies receiving a bulk supply may use data gathered by the supplying company from its supply point in place of supply zone data. Further details along with information on how to apply for such arrangements are detailed in Information letter 18/2003 . If such arrangements are put in place for bulk supplies that are used on an intermittent basis the two companies must ensure procedures are in place to guarantee the supply is sampled when the bulk supply is in use. Companies are also reminded of the need for appropriate arrangements to ensure clear communication in the event of water treatment, water quality, sampling or analysis problems and the appropriate transfer of data.

Regulation 8(2) - Authorisation of parameters for supply point monitoring

14.10. Regulation 8(2) allows the Inspectorate to authorise sampling from supply points instead of sampling points (consumers' taps) for parameters other than those specified in regulation 8(1). In this instance a supply point may be any of the types of point specified under regulation 8(1) or any other point.

14.11. Such authorisation will only be granted when the Inspectorate is satisfied that the results of the analysis of samples taken from the supply point are "unlikely to differ in any material respect" for a particular parameter from the results that would be produced from the analysis of samples taken from sampling points. Where the Inspectorate authorises particular parameters to be monitored at supply points, the sampling frequency should be that applying to audit monitoring in Table 3 of Schedule 3. Companies should remain on supply point monitoring for a full calendar year unless the supply point authorisation is revoked or modified.

14.12. In respect of the following parameters, it is unlikely that authorisation to sample from supply points will be given because the results may "differ in a material respect":

i. *E.coli*, coliform bacteria and colony counts, as these are likely to change in concentration through the distribution system;

ii. lead, copper, nickel and chromium because these metals can be present from contact of the water supplied with plumbing materials;

iii. iron, manganese and aluminium because these metals can be present in water leaving treatment works and picked up from deposits in the distribution system;

iv. polycyclic aromatic hydrocarbons and benzo(a)pyrene because these substances can be present from contact of the water supplied with coal tar pitch linings within the distribution system;

v. colour, taste, odour and turbidity because these characteristics of the water supply can be affected by the condition of the distribution system and consumers' plumbing systems;

vi. hydrogen ion because this can change as the water passes through the distribution system and by treatment equipment within consumers' premises;

vii. sodium because this can increase when sodium hypochlorite is added during distribution and when treatment equipment is used within consumers' premises;

viii. ammonium and nitrite because these concentrations are likely to change as the water passes through the distribution system due to microbiological reactions and when chloramination is practised;

ix. nitrate as it should be sampled at the same time and place as nitrite because of the need to calculate the nitrate / nitrite formula; and

x. trihalomethanes when the water supply originates from or is influenced by surface water as the concentrations leaving the treatment works are likely to vary significantly as the water passes through the distribution system (some groundwaters may be influenced by surface waters when water quality changes occur as a result of rainfall or changes in river flows).

14.13. Authorisation to sample from supply points could be considered in the following circumstances because the results may not differ in "any material respect":

i. for antimony, arsenic, cadmium and selenium when the water company can demonstrate for a particular supply or supplies that these metals have not been detected at significant concentrations in samples taken from consumers' taps for at least two years; and

ii. for trihalomethanes when the water supply zones are supplied with water that originates solely from groundwater and the water company can demonstrate that the concentrations at consumers' taps have been an average (mean) of 30 µg/l or less for at least two years and not exceeded 50 µg/l in that time.

14.14. The Regulations do not specify a supply point audit frequency for the parameters listed in paragraph above. In the case where a supply point authorisation is granted for any of the parameters listed, companies will be expected to adopt the relevant supply point audit frequency specified for other parameters (that is items 9-25 in Table 3 Schedule 3).

14.15. The granting of an authorisation under regulation 8(2) requires a written application from the water company. Details of how to apply are given in Information letter 9/2003.

15. Regulation 9(1) – Numbers of samples

15.1. Regulation 9(1) requires companies to take the standard number of samples from its sampling points (consumers' taps) or, where appropriate, supply points for analysis for the parameters listed in Tables 2 and 3 of Schedule 3. The Inspectorate recognises that this is a potentially complex sampling regime. The following examples

are intended to illustrate the process for two of the more complicated parameters, nitrite and nitrate. These cover the audit and check monitoring requirements outlined above and includes the monitoring for nitrite required at treatment works under regulation 13.

Example A

A water treatment works, which practises chloramination, has an annual average output of 25,000 m^3/d and supplies three water supply zones with populations of WSZ1 25,000, WSZ2 35,000, and WSZ3 65,000.

Monitoring required at WTW
Nitrite (against standard of 0.1mg/l) – 365 samples per annum (standard frequency)

Check monitoring required in water supply zones
Nitrite (against standard of 0.5mg/l) and nitrate (against standard of 50 mg/l)
WSZ1 – 24 samples per annum (at standard frequency)
WSZ2 – 36 samples per annum (at standard frequency)
WSZ3 – 52 samples per annum (at standard frequency)

Example B

A water treatment works, which does not practise chloramination, has an annual average output of 10,000 m^3/d and supplies two water supply zones with populations of WSZ1 4,000 and WSZ2 56,000.

Audit monitoring required at WTW
Nitrite (against standard of 0.1mg/l) – 8 samples per annum

Audit monitoring required in water supply zones
Nitrite (against standard of 0.5mg/l) and nitrate (against standard of 50 mg/l)
WSZ1 – 4 samples per annum
WSZ2 – 8 samples per annum

16. Regulation 9(2) – Reduced sampling frequency

16.1. Regulation 9(2) allows a water company to take a reduced number of samples for those parameters that are subject to check monitoring provided specified conditions are met.

One of the conditions is that the water company is of the opinion that the quality of water supplied by it to a water supply zone is unlikely to deteriorate. DWI expects Water company judgements whether reduced frequency can be applied should be informed by their raw water monitoring activities and their regulatory risk assessment for the relevant supply system, in particular an assessment of whether there;

i. has been any change in the activities within the catchment or the condition of the catchment which is likely to have an adverse effect on the quality of the raw water;
ii. is any evidence of a general deterioration in the quality of the raw water, or the water supplied from the treatment works
iii. is any evidence of a general deterioration in the quality of water as it passed through the distribution system to consumers' properties.

16.2. Another of the conditions is that the results of the analysis of samples in each of two successive years (or the results of the last 12 samples where less than this number has been taken in two years) show no significant variation and, except for colony counts and pH value, the concentration or value is significantly lower than the prescribed concentration or value. The following paragraphs give guidance on specific parameters.

i. For aluminium, ammonium, colour, conductivity, iron, manganese, nitrate, nitrite and turbidity, a significant variation is when any result deviates from the arithmetic mean concentration or value, in either of the two years, (or in the results of the last 12 samples where less than this number has been taken in two years) by more than 20% of the prescribed concentration or value. For these parameters significantly lower is when all the values in each year (or in the results of the last 12 samples where less than this number has been taken in two years) are below 50% of the prescribed concentration or value.

ii. For taste and odour a reduced frequency can only be applied when all the results in the previous two years (or in the results of the last 12 samples where less than this number has been taken in two years) have been less than a dilution number of 1 and there has been no significant increase in the number of consumer complaints in a given water supply zone.

iii. For *Clostridium perfringens* (including spores) a reduced frequency can only be applied when the organism has not been detected in any of the samples taken in the two years (or in the results of the last 12 samples where less than this number has been taken in two years).

iv. For colony counts, no significant variation and no abnormal change is when all the results obtained in the two years (or in the results of the last 12 samples where less than this number has been taken in two years) are within plus or minus one order of magnitude of the mean for that zone. In cases where the mean value is less than 2/ml, individual results up to 20/ml can be taken as indicating no significant variation and no abnormal change.

v. For the hydrogen ion parameter, no significant variation is when all the results for pH value in the two years (or in the results of the last 12 samples where less than this number has been taken in two years) are within a spread of 1 pH unit. A reduced frequency cannot be applied when any of these results are below a pH value of 6.5 or above a pH value of 9.5.

17. Regulation 9(4) – Numbers of samples: regular intervals

17.1. Regulation 9(4) requires samples to be taken at regular intervals. Regular sampling means that there is a suitable spread of samples to detect possible variation in water quality. Variation could occur on long term (seasonal) or more short term basis (within a week or day due to operational changes). The requirement for regular sampling does not mean that the sampling occasions have to be spread at exactly equal intervals.

17.2. For water supply zones the most common sampling frequencies are 12, 24 and 36 per annum. Samples should generally be taken at one, two or three times per month. It is important that there is a good spread between the sampling events. For sampling frequencies of 52 and 76 per annum samples should be taken once and sometimes twice a week to meet the targets. Ideally the day within each week that the sample is taken should be randomised. However it is recognised that it may not be practicable to fully randomise the day of sampling. Where the sources of supply or operation of a works, service reservoir or zone are known to vary significantly over the period of a week, the sampling programme should be managed to ensure some variation in the day of the week in which the sample is taken.

17.3. If a water company fails to take or analyse a sample, through no fault of its own, e.g. a broken sample bottle, it will be expected to reschedule a further sample as soon as possible. The resample should be taken well in advance of the next programmed sample. The Inspectorate considers that only in exceptional circumstances will it not be possible to resample in advance of the next programmed sample. Each case will be reviewed on its merits. Since the Regulations require the frequencies to be met on an annual basis rescheduling does not constitute a shortfall. Provided the resampling is prompt, occasional occurrences of this type will not be regarded as a failure to meet the regularity requirement.

17.4. The requirement for regularity does not apply to raw water monitoring carried out under regulation 16A.

17.5. A summary of the sampling requirements for each parameter is given in Appendix 6.

18. Regulation 10 – Sampling: further provisions

18.1. Regulation 10 requires companies to take additional samples as part of their statutory monitoring programme for any element, organism or substance that they have reasonable grounds for believing that may cause the water to be unwholesome. Companies should take into consideration the findings of raw water monitoring, regulatory risk assessments, and other (e.g. operational and investigatory) monitoring as well as general developments in scientific knowledge of drinking water safety and any specific guidance provided by the Inspectorate.

PART V – MONITORING – ADDITONAL PROVISIONS

19. Regulation 13 – Sampling at treatment works

19.1. Regulation 13(1) requires water companies to ensure that samples for *E.coli*, coliform bacteria, colony counts, residual disinfectant, turbidity and nitrite are taken at the required frequency from the point at which water leaves each treatment works. The frequencies are set out in Table 3 of Schedule 3. All six parameters should be monitored at the flow related frequencies set out against items 1 to 6. In the event of chloramination not being practiced, the frequency for nitrite should be that specified against item 16 rather than against item 4.

19.2. Regulation 13(2) provides for a reduced frequency of sampling for the colony counts parameter when there has been no significant increase in the counts in each of two successive years. Colony counts, particularly for surface water derived supplies, are likely to vary seasonally because of changes in quality and temperature. A significant increase should be regarded as a count which is more than one order of magnitude greater than that normally expected for the time of year the sample was taken for the works in question.

19.3. Regulation 13(4) provides for a reduced number of samples for the coliform bacteria parameter and the *E.coli* parameter only when the water company is of the opinion:

(a) that there is no foreseeable risk that the supply will exceed the maximum concentration for the parameter; or

(b) that the treatment works is at all times designed, maintained and operated in a way that fully complies with regulation 26 and, in the event of a failure of the treatment processes, water that has not been adequately treated and disinfected cannot enter the supply.

19.4. In respect of paragraph 19.3 (a) above, a water company would be expected to take into account all relevant factors identified through its regulatory risk assessment which will have included the factors in earlier editions of this guidance which are repeated below for convenience:

(i) risk factors and activities in the catchment from which the water source is drawn;

(ii) the concentrations of the parameter in the raw water;

(iii) the nature and capability of the treatment processes at the works; and

(iv) the concentration of the parameter in the water leaving the treatment works over the previous two years.

19.5. In respect of 19.3 (b), this requirement would be met when:

(i) a treatment works automatically shuts down almost immediately after a disinfection failure is detected through appropriate alarms; or

(ii) procedures are in place for a treatment works to be manually shut down almost immediately after an appropriate alarm warning of a failure of adequate treatment and disinfection.

19.6. It is unlikely that a reduced frequency could be applied to only one of the coliform bacteria or *E.coli* parameters.

19.7. Regulations 13(2) and 13(4) deal with the adoption of reduced frequency monitoring. Where there is a failure to meet the PCV or an exceedence of an indicator parameter value occurs at a treatment works where reduced frequency monitoring has been adopted, sampling should be increased to the standard frequency on a pro rata basis for the remainder of that year and the two following calendar years.

19.8. Sampling frequencies are normally based on the volume of water supplied in m^3/day. Sampling frequencies should be based on the average daily output from the works during the previous calendar year except where it is known that the current year's average daily output will be significantly different from the previous year's average daily output. Where there is more than one outlet at a works requiring separate sampling points (as explained in earlier sections), the sampling frequency should be determined separately for each sampling point based on the average daily output at each point.

19.9. Normally water companies would be expected to establish prior to the start of the calendar year, their annual sampling frequency for each works based on the previous year's average daily output from the works or the anticipated average daily output for the current year. Water companies with treatment works whose output may vary considerably at different times of the year for extended periods should consider adjusting the frequencies in accordance with the average daily output for those periods.

19.10. Regulation 13(5) requires samples to be taken at regular intervals. For water treatment works sampling frequencies may range from 2 to 2,190 per annum. A sample frequency of 365 per annum requires a sample to be taken on each calendar day of the year (and should include February 29 in each leap year). For sample frequencies in excess of 365 per annum, samples should be taken over as large a daily span as is possible. They do not have to be spread at exactly equal intervals but should be broadly spread to be representative of any potential changes in water quality during the day. There must be a mechanism to pre-determine the time of sampling

19.11. For works on daily sampling, if a water company fails to take or analyse a sample through no fault of its own e.g. a dropped sample bottle, it will be expected to reschedule a further sample for the same day if possible or the following day. On the following day the resample should be taken at a significant time interval before or after the sample programmed for that day. Since the Regulations require the frequencies to be met on an annual basis rescheduling does not constitute a shortfall. Provided the resampling is as described above an occasional occurrence will not be regarded as a failure to meet the regularity requirement.

19.12. For sampling purposes a treatment works is considered to be in service on every day (midnight to midnight) that any treated water is supplied from the works.

Monitoring: Analysis using monitors

19.13. Regulation 16(3) extends the scope of the term "laboratory" to a person who may undertake analysis at the time when, and place at which, the samples are taken. This allows the potential use of results from continuous water quality monitors for certain parameters e.g. turbidity, conductivity and residual disinfectant. This section has been included here because it is envisaged that the most likely use of such monitors will be at treatment works.

19.14. In general, on-line monitors at water treatment works or service reservoirs may be used for regulatory analysis provided it can be shown that the particular monitor is:

i. Capable of providing fit for purpose data (as defined in regulation 16 or this Guidance);
ii. sited to ensure that results are representative of the water being supplied;
iii. maintained and operated to a demonstrably high standard at all times;
iv. calibrated in a way that is valid, appropriate and traceable;
v. subject to reliable quality checks at an appropriate frequency;
vi. the date and time of each compliance reading is specified in advance of the start of the compliance year;
vii. there is a traceable means of demonstrating that the recorded reading is the true reading of the instrument at that time; and
viii. there are robust and effective means for sampling and analysis whenever the monitor is out of service or performing unreliably.

19.15. Existing monitors for total chlorine, free chlorine, turbidity and conductivity may be demonstrated as meeting requirements (i) and (ii) above by comparing results of analysis using the current regulatory method with the instrument readings at the times of sampling. Provided the difference between the means is not greater than 10% of the result or 5% of the PCV, whichever is the greater, and the 95% confidence interval for the difference of an individual pair of results (difference between paired instrument result and compliance method result) is not greater than 20% of the result or 10% of the PCV, whichever is the greater, the results will be acceptable. Not fewer than 20 pairs of results covering at least one year should be used for the comparison. Only installations which satisfy these requirements may be used for compliance monitoring purposes.

19.16. Quality control checks should take the form of comparisons of instrument readings with results obtained using the compliance method at a frequency of 1 check for every 10 compliance results reported. For high frequency measurements, fewer checks may be carried out (up to 1 in 50) provided the suitability of the selected frequency can be demonstrated. A separate difference type control chart must be set up for each monitor, with standard rules for interpretation of the chart and action in the event of evidence of loss of control.

19.17. Fully documented and controlled procedures and records, to the standards required in laboratories, are required to demonstrate compliance with the other requirements. These records must be sufficient to satisfy the requirements of regulation 16(4).

19.18. Companies wishing to use monitors for other parameters, or new types of monitors for any parameter, must demonstrate that the monitor is capable of achieving all the performance requirements set out in the Regulations or, for chlorine and total organic carbon appendix 1 to this Guidance, before demonstrating that all the other

requirements are met. Only once this has been done can the monitor be used for compliance purposes.

19.19. Where the sample passing through an on-line monitor is returned to the process flow then these instruments must comply with the requirements of regulation 31(4)(b). Where the water passing through the monitor is discharged to waste then these requirements do not need to be met.

19.20. Monitors, installations, staff, procedures, records, results and all other relevant data will be subject to audit by the Inspectorate.

20. Regulation 14 – Sampling at service reservoirs

20.1. Regulation 14 requires water companies to take a sample from every reservoir every week it is in use. These samples must be analysed for coliform bacteria, E.coli, colony counts and residual disinfectant.

20.2. Ideally the day within each week that the sample is taken should be randomised. However it is recognised that it may not be practicable to fully randomise the day of sampling and in such cases the sampling programme should be managed to ensure some variation in the day of the week in which the sample is taken.

20.3. If a water company fails to take or analyse a sample through no fault of its own e.g. a broken sample bottle, it will be expected to reschedule a further sample for the same week. In exceptional circumstances, if a sample cannot be programmed the same week the Inspectorate may take a pragmatic view of the shortfall, provided the resample is scheduled for the following week on a day separate from and not consecutive to the day of the sample programmed for that week.

21. Regulation 15 – Sampling: new sources

21.1. Regulation 15 outlines the sampling requirement for:

i. sources that have not been used since 1 Jan 2004; and

ii. sources that have not been used for a period of six months.

21.2. Those in category (i) must be sampled before they are put into supply and those in category (ii) may be sampled as soon as practicable after the source is put into supply. However companies should consider how Regulations 16A, 26, 27, 28 might change their approach to sampling of sources as set out in regulation 15.

21.3. The sampling for a source in category 21.1(i) above must include all the parameters in Schedules 1 and 2 of the Regulations and any other element, substance or organism likely to make the supply unwholesome. The sampling for sources in category 21.1(ii) above must include the parameters in Table A of Schedule 1, conductivity, hydrogen ion and turbidity and any other parameter that the company considers is likely to have changed since the supply was last used.

21.4. There is no regulation 15 requirement to sample sources which have been out of supply for less than six months when they are first used again. However companies would be prudent to conduct some monitoring for key parameters prior to introducing

such sources, dependent on the time since the source was last in use. All such sources must be included within the regulatory risk assessment for the treatment works and associated supply system. The risk assessment should inform the selection of monitoring parameters. Companies should make sure that the parameters in their regulation 16A (raw water) monitoring programme are appropriate for when intermittent sources are in use, as well as at other times.

21.5. Sources that have not been used for over six months but have been used since 1 January 2004 must be subject to limited monitoring after return to supply. The scope of the monitoring required should be informed by the regulatory risk assessment for the treatment works and the associated supply system. Depending on the circumstances, the risk assessment may require revision, although companies should have ensured that each risk assessment, when first prepared, recognises the hazards potentially involved with the bringing back on line of all existing standby or emergency sources. Companies should make sure that the parameters in their regulation 16A (raw water) monitoring programme are appropriate for when standby sources are in use, as well as at other times.

21.6. Regulation 15 requires new sources or those not used since 1 January 2004 to be subjected to full monitoring prior to introduction into supply. Additionally, regulation 15 specifies that such a source cannot be used until a regulation 27 assessment has been carried out and three months have elapsed from receipt by the Inspectorate of a regulation 28 risk assessment report. However, there is an exception allowed within the regulations for circumstances whereby the source is required as a matter of urgency in order to prevent an unexpected interruption in piped supply to consumers although a risk assessment under regulation 27 would still be required before the supply is made. As a matter of good practice it is expected that development of new sources would be informed by relevant historic data under the current and previous regulations, as well as contemporaneous data. Companies will need to review and if needs be adjust their regulation 16A (raw water) monitoring programme when they introduce a new source.

21.7. All bulk supplies between companies, and transfers to others such as new applicants, or traded abstractions, should be regarded by the receiving company as new sources that are subject to regulation 15 requirements.

22. Regulation 16 – Collection and analysis of samples

22.1. Regulation 16 specifies the minimum quality requirements for the taking, handling, storage and analysis of samples taken for the regulatory monitoring of water supplies. These requirements are set out in regulations 16(2) and 16(5). Regulation 16(4) sets out the requirement for the retention of records to demonstrate that the sampling, transport, storage and analysis of each sample complied with the requirements. Other paragraphs cover definitions and the procedure for authorising the use of alternative methods for microbiological analysis.

Regulation 16(2)

22.2. Regulations 16(2)(a) and 16(2)(b) require that the sample is representative of the quality of the water being sampled at the time of sampling and that the sample is not subject to contamination when being taken. Regulation 16(2)(c) specifies that samples must be kept in conditions that will ensure that the sample does not deteriorate in any significant way between sampling and the commencement of analysis.

22.3. Water companies, or their sampling contractor, should produce a comprehensive sampling manual setting out the procedures and precautions to be adopted for each parameter or group of parameters. Guidance on all aspects of sampling can be found in the BS EN ISO 5667 series of Standards.

Sampling Manual for microbiological parameters

22.4. As a minimum, the sampling manual should include relevant information on the types of sample bottle, the preparation of sample bottles, the sampling procedures and the transportation of samples. Details of recommended sampling procedures are given in the Microbiology of Drinking Water and BS EN ISO 19458.

Sampling Manual for all other parameters

22.5. The nature of parameters varies widely, and a range of sample containers, cleaning regimes, and methods of sample preservation and storage will be required. For example, mercury is highly volatile even at low temperatures, and requires the addition of preservative at the time of sampling. Polycyclic aromatic hydrocarbons react with chlorine and are light-sensitive and require the immediate destruction of chlorine and storage in the dark. Other parameters are volatile or subject to biological degradation and require immediate refrigeration.

22.6. As a minimum the sampling manual should specify:

i. the types of bottles or containers, their means of and type of closures and the purposes for which they are to be used;

ii. where relevant, the cleaning procedure and shelf life for bottles, containers and closures used for each parameter, including the amount and type of preservative to be added;

iii. the sampling procedure for each parameter, including the type of sample to be collected (e.g. first draw, flushed, stagnation) and the procedure for collecting samples for different parameters;

iv. the order of sampling; and

v. the conditions of storage and transport of samples and the maximum time that can elapse before analysis should commence, for each parameter.

22.7. Further general information on sampling procedures is given in ‘General Principles of Sampling and Accuracy of Analytical Results’ in the series ‘Methods for the Examination of Water and Associated Materials’ published by the Standing

Committee of Analysts. Detailed information for individual parameters or groups of parameters is given in the individual booklets in the same series.

Training of samplers

22.8. In order to carry out sampling correctly it is essential that all samplers are fully trained and have been authorised as competent before they are allowed to work unsupervised. The water company or its sampling contractor should produce a comprehensive sampler training programme to cover all aspects of sampling.

Once trained, all samplers' performance should be monitored and subject to regular audit. Monitoring and audit procedures and criteria for satisfactory performance and policy on retraining should be documented. A training record should be produced for each sampler detailing the training given, with dates and assessment of competence, results of any audits, any retraining or further training given and any re-assessment of competence.

Analysis of samples

22.9. Regulation 16(2)(d) requires that all samples are analysed as soon as possible after they have been taken, by or under the supervision of a competent person using suitable equipment. Detailed advice on this part of the Regulations is given in Appendix 1.

Part VA – DRINKING WATER PROTECTED AREAS

23. Regulation 16A – Drinking water abstraction points: monitoring sites

23.1. Regulation 16A concerns the collection and analysis of samples of raw water used by water companies for regulation 4(1) purposes. The purpose of this sampling is primarily to provide information to inform regulatory risk assessments but will also contribute to the body of information identified as being necessary for every member state to collect in support the objectives of the Water Framework Directive.

23.2. Regulation 16A(1) requires water companies to identify every abstraction point from which water is drawn for regulation 4(1) purposes. As part of each regulatory risk assessment DWI expects companies to document every licensed abstraction point irrespective of whether a source is used continuously, intermittently or as standby and emergency sources. However for the purpose of collecting regulation 16A(2) samples of raw water, companies may use a sample point located at the treatment works end of any pipe or set of pipes conveying water from the abstraction point(s) (usually such a sample point is known as the combined inlet to the works). If a single combined inlet sample point is not located so as to be representative of all the water that may enter the treatment works then the company will need to use more than one sample point. These may be located either at the individual abstraction point(s) or at the treatment works end of each pipe conveying water from an abstraction point to the treatment works.

23.3. Every sample point must have a unique reference number and its relationship to licensed abstraction points and the aquifer or the body of surface water must be recorded. When selecting sample points, companies must ensure that they are located upstream of any treatment intended to modify water quality in respect of any parameter, substance, micro-organism or parasite. Treatment in this context includes blending where this is undertaken deliberately to modify the quality of water e.g. blending of high nitrate water with water from a low nitrate source, it also includes dosing to adjust the concentration of fluoride or alter the pH.

23.4. Regulations 16A(3) and 16A(4) give the Inspectorate the power to specify the number of raw water samples to be taken and the nature of the analysis to be carried out and to change these requirements. The Inspectorate will form a view as to the need for such notices following assessment of companies regulation 28 risk assessment reports and the raw water monitoring data submitted by companies. This general position does not preclude the Inspectorate from issuing such a notice sooner as a consequence of audit findings or an assessment of a notified event.

23.5. Regulation 16A (5) sets minimum sampling frequencies for surface water which derive from the Water Framework Directive but in practice it is expected that companies will exceed these frequencies when considering what sampling frequency is necessary to demonstrate compliance with new regulation 26 and to support regulatory risk assessments.

23.6. The Regulations do not specify a minimum sampling frequency for raw waters from groundwater sources. However companies are expected to take into consideration historical water quality trends, monitoring data available from other bodies (such as the Environment Agency) and established practice for determination of sampling programmes to indicate changes or trends in raw water quality (such as technical guidance produced by the United Kingdom Technical Advisory Group (UKTAG) that

supports the implementation of the European Community (EC) Water Framework Directive (Directive 2000/60/EC)).

23.7. Arrangements are in place for companies to submit raw water monitoring data to the Inspectorate, the details of which are outlined in Information Letter 04/2009. The Inspectorate will share companies' raw water data with the Environment Agency in line with the principles of better regulation for the purposes of contributing to the UK monitoring under Article 7 of the Water Framework Directive. Companies should ensure that they have in place local arrangement for the sharing of other data or information required for the assessment of risks as part of their regulatory risk assessments (see later sections).

PART VI – INVESTIGATIONS, AUTHORISATION OF DEPARTURES & REMEDIAL ACTION

24. Regulation 17 – Investigations: Schedule 1 parameters

24.1. Regulation 17(1) requires a water company that has reason to believe that the water supplied fails, or is likely to fail, to meet the standards of wholesomeness specified in regulation 4 and Schedule 1, to investigate the cause of that failure or likely failure. Similarly regulation 17(3) requires a water company to investigate the cause of any failure or likely failure to meet the concentration or value required in an authorisation. Regulation 17(2) sets out the actions that an water company is required to take, including establishing the cause and extent of the failure, the Schedule 1 parameter(s) that have not met (or are unlikely to meet) the regulations and whether the failure is related to the domestic distribution system (see regulation 17(2)(c) below).

24.2. A summary of the investigation process for Schedule 1 parameters is given in Appendix 3. Note that where the Inspectorate decides that the exceedance is trivial or unlikely to recur then no further action is necessary.

24.3. The definition of a failure is clear. It is when the analysis of a sample taken as required by the Regulations exceeds a concentration or value specified for the parameters in Schedule 1 of the Regulations. However, the terms of “likely to fail” or “likely failure” are not defined in the Regulations.

24.4. A water company may have reason to believe that the water supplied is likely to fail in the following circumstances:

i. there is evidence from the analysis of samples taken as required by the Regulations that the trend in the concentration or value of a particular parameter is generally and steadily increasing (or decreasing) towards the prescribed concentration or value and if that trend continues the water is likely to fail to meet the prescribed concentration or value in the future, say within five years. Such evidence may be available for the nitrate parameter for example;

ii. no regulatory samples are in breach of the prescribed concentration or value for a particular parameter but there is evidence from the analysis of non-regulatory samples such as operational control samples or samples taken in response to events or consumer complaints that the prescribed concentration or value has been breached;

iii. no regulatory samples have exceeded the prescribed concentration or value for a particular parameter but there is evidence from the analysis of non-regulatory samples such as operational control samples or samples taken in response to events or consumer complaints that the concentration or value is generally and steadily increasing (or decreasing) towards the prescribed concentration or value, and if that trend continues the water will fail to meet the prescribed concentration or value in the future, say within 5 years.

Taste and Odour

24.5. The standards for taste and for odour are descriptive in line with the requirements of the Drinking Water Directive. These are mandatory national standards and a positive detection by panellists should be treated by companies as a breach of the descriptive standard for taste and odour (abnormal and unacceptable to consumers) and act accordingly. Consequently, when detected, either qualitatively or quantitatively, any detection of taste or odour must be investigated to establish whether the finding is abnormal, relative to previous results from the zone, taking into account seasonal variations. Use of the Standing Committee of Analyst's (SCA) dilution number method (Microbiology of Drinking Water, Part 11 Taste Odour and Related Aesthetic Problems) continues to be recommended as part of the investigation to characterise the intensity. Consumers expect their water to exhibit no objectionable taste and odour. Judgements about acceptability will require the company to have regard to its records of consumer contacts about taste or odour reported for the zone as a whole. However company investigations of both compliance samples and consumer complaints should be guided initially by the description of the taste and odour and the likely contribution of the domestic plumbing at the property from where the sample was taken, as well as the likelihood of a problem stemming from contamination of the supply pipe or being due to a wider problem, such as backflow or back-siphonage from neighbouring properties.

24.6. Any positive detection of taste or odour should be allocated a descriptor from the list published in the most recent SCA method. The descriptor should guide the water company as to the most probable cause and thus the nature of the investigation e.g. a pencil taste is characteristic of the use of pipes made from a material that is not approved under regulation 31 or WRAS (Water Fittings Regulations 1999). Where the cause is due to customers' pipes or fittings then companies should notify the occupiers and the local authority in writing (see below). Guidance on the reporting of taste or odour failures is given in Information Letter 05/2009.

25. Regulation 17(2)(c) – Failures attributable to the domestic distribution system

25.1. Regulation 17(2)(c) requires water companies to investigate whether a failure to achieve the prescribed concentration or value may be attributable to the domestic distribution system or its maintenance or neither.

25.2. Bacteriological parameters may be influenced by the condition of the domestic distribution system and particularly the design and hygienic status of the consumer's tap. Where a failure to achieve the prescribed concentration for enterococci and E.coli occurs the water company should investigate the cause by taking further samples which may include:

- the original sample point
- alternative consumer taps (only taps directly connected to the supply main) at the same property and at adjacent or nearby properties
- sampling from related points upstream and downstream in the distribution main
- checks on performance of the treatment works and samples from any service reservoir

25.3. Additional information may be obtained by:

- a review of the outcome of analyses from other samples that may have been taken from related water supply areas at a similar time to the original sample
- taking a sample prior to and after disinfection of the consumer tap
- taking a swab sample from the surfaces of the tap that come in contact with the water supply

25.4. The outcome of the further analysis provides important information on the likelihood that the failure to achieve the prescribed concentration is attributable to the domestic distribution system. There is a strong indication that the failure is attributable to the domestic distribution system in any of the following circumstances:

i. the failure to meet the prescribed concentration recurs at the original consumer's sample tap but all other samples meet the relevant prescribed concentrations;

ii. the failure to meet the prescribed concentration recurs in a sample taken before disinfection of the original consumer's sample tap but a sample taken following disinfection meets the relevant prescribed concentrations and all other samples meet the relevant prescribed concentrations;

iii. the failure to meet the prescribed concentration does not recur at the original consumer's sample tap but enterococci or *E.coli* are recovered from a swab sample taken from the surfaces of the tap and all other samples meet the prescribed concentrations; or

iv. the failure can be shown to be attributable to an upstream device e.g. softener, filter or point of use treatment device or from some other unit connected to the domestic plumbing e.g. washing machine or dishwasher. Note: There must be evidence as to causation that is more than the mere existence of such devices.

25.5. Where water companies can demonstrate that failures to meet the prescribed concentrations were likely to be attributable to the domestic distribution system in premises where water is not supplied to the public then the individual results on the public record should be qualified by appropriate comments.

25.6. Where the companies investigations indicate that the failure is attributable to the domestic distribution system (or maintenance thereof) of a premises in which water is made available for use by members of the public (including schools, hospitals and restaurants) then regulation 19A applies – see later section.

Copper, lead and nickel

25.7. Failures to achieve the prescribed concentration for copper, lead and nickel at the consumer's tap are commonly associated with the domestic distribution system as the water interacts with copper or lead pipes (or solders) and both metal and plastic fittings may release nickel[4]. Failure for copper or lead may be due (in part) to water

[4] Sanitary tap fittings are commonly made from thermoplastic materials. In order to externally plate these fittings, a metallic layer of nickel is applied to the plastic body; as part of this process some of the nickel can "over-spray" into the spout of the tap. If subsequent plating over the nickel does not cover the "over-spray" this may lead to subsequent leaching of nickel.

company pipes. The water company should investigate the extent of these interactions by taking additional unflushed samples following defined periods of stagnation and from nearby properties. Visual checks should also be carried out for any lead piping supplying the tap in the case of a lead failure. Nickel is more likely to be related to tap fittings therefore comparisons between unflushed and flushed samples can be useful. It should be remembered that lead can occur in water even when lead pipes are absent, specifically in copper plumbing systems where lead solder has been used in contravention of the Water Supply (Water Fittings) Regulations 1999.

25.8. Failure of the prescribed concentration for copper may occur in houses with new copper plumbing or where a significant amount of copper pipe has been replaced. Following a failure to achieve the prescribed concentration for copper, the domestic distribution system should be inspected to ensure that it meets the requirements of the Water Supply (Water Fittings) Regulations 1999.

25.9. Unless the water company can demonstrate that the failure to achieve the prescribed concentration for copper or lead was due to exceptional circumstances and was therefore unlikely to recur, regulation 17(9) requires the water company to modify or replace its pipes or fittings that have potential for contributing to copper or lead in the water supplied to the premises. In addition to these requirements, regulation 30 contains additional requirements regarding lead pipe replacement following a request from the consumer.

26. Regulation 17(6) – Notification of consumers

26.1. Regulation 17(6) requires a water company that has identified by its investigation that a failure is due to the domestic distribution system or to the maintenance of that system to notify affected consumers in writing of the nature of the failure and to relay steps (if any) that the water company advises are desirable for the consumers to take in the interests of their health. Water companies should seek advice from their local Health Protection Unit and local authority Environmental Health Department as appropriate in respect of this; however the decision to issue advice to consumers is a matter for the water company. In making this decision the company should have due regard to the advice sought and received from local health professionals.

26.2. The notice from the water company should inform the consumer in simple layman's terms:

i. the parameter that has failed;
ii. the concentration or value of that parameter in the sample taken from the consumers' premises;
iii. the prescribed concentration or value of that parameter;
iv. the significance of the failure (e.g. if the water company considers that advice on health matters should be sought); and
v. the reason for the failure.

26.3. The notice must also inform the consumer of the steps he/she should take. These steps will depend on the nature of the parameter and the cause and extent of the failure. Examples of the steps that the water company may consider are:

i. **failures of microbiological parameters** – advise boiling water for drinking and food preparation pending investigation of the problem – a plumbing inspection

may assist in the investigation - where the failure is associated with an individual fitting advise repair or replacement of the pipework or fitting causing the problem

ii. **failures of the lead parameter (or other plumbing metals)** – advise drawing off the water standing in the pipework and using for purposes other than drinking or food preparation – advise consideration of replacing the pipework within the premises contributing to the failure

iii. **failures of other parameters** are likely to be caused by ingress to the pipework within the consumer's premises (by permeation, leaking pipes or back siphonage) – advise where necessary and appropriate boiling water for drinking and food preparation or not to use water for drinking and food preparation – advise a plumbing inspection - where the failure is associated with an individual fitting advise repair or replacement of the pipework or fitting causing the problem.

27. Regulation 18 – Investigations: indicator parameters

27.1. Regulation 18(1) requires a water company, when it has reason to believe that the water supplied does not meet the specification for indicator parameters, to investigate why the specifications were not met and, if the specification for coliform bacteria or the colony count parameter is not met, whether the cause was the domestic distribution system or the maintenance of that system or neither. Such an investigation must be carried out when a sample taken in accordance with the Regulations does not meet the specification for an indicator parameter. Investigations should also be carried out when an operational sample or a sample taken in respect of an event or a consumer complaint does not meet the specification for an indicator parameter.

27.2. The Water Supply Regulations 2010 amended regulation 18(1) to bring it in line with the requirements of the Drinking Water Directive and require immediate investigation of non-compliance with indicator specifications. The Inspectorate considers that immediate investigation includes an initial assessment of the likely significance of not meeting an indicator specification in terms of public health, which should be subsequently followed up by further investigations into the nature and cause of the failure.

27.3. Regulation 18(2) requires the water company as soon as its investigations are complete to notify the Inspectorate of results of the investigations and whether the inability to meet the specification is likely to recur. Existing arrangements for the notification of events and compliance sample results should be used for this purpose.

27.4. If a particular parameter for a water supply zone or group of water supply zones supplied by the same water treatment works does not meet the specification for indicator parameters, and the water company notifies the Inspectorate that it has not met the specification and the inability to meet it is likely to recur, then the water company need not investigate and notify on each subsequent occasion that the specification is not met, provided it is clear that the cause is the same and there are no changes in circumstances. If it is likely that the cause is different or there has been a change in circumstances the water company must carry out the investigations and the notification. This paragraph only applies to those indicator parameters that are unlikely to be affected by the domestic distribution system or the maintenance of that

system – i.e. chloride, Clostridium perfringens (including spores), conductivity, sulphate, total indicative dose (for radioactivity), total organic carbon (TOC), tritium (for radioactivity) and turbidity.

27.5. All occasions when the specifications for indicator parameters are not met at consumers' taps must be investigated. In particular, investigations for coliform bacteria or colony count failures must address whether the inability to meet the specification is due to the domestic distribution system or the maintenance of that system. When it is due to the domestic distribution system the water company must notify the affected consumers and inform them of the nature of the problem and any steps that the water company or Health Protection Agency consider it desirable for the consumers to take in the interests of their health. Water companies should provide appropriate technical advice and may refer consumers to their Local Authority Environmental Health Department or the local Health Protection Unit of the HPA for advice on health matters. For the microbiological parameters appropriate steps could be to boil water for drinking and food preparation and to get a plumbing inspection to identify the cause of the problem and to rectify the cause.

27.6. Most indicator parameters do not have a direct influence on health but are included in the monitoring programme because they may indicate a problem or potential problem with the treatment or distribution of the water. In all cases (except those described in 27.4 above) failure to meet an indicator specification must be followed by an investigation by the water company. In many cases a change in the level of an indicator parameter may be more significant than the failure to meet a particular value. In many cases the nature of the raw water source will influence the significance of changes and exceedences of an indicator parameter's specification.

(i) Ammonium (specification: 0.50 mgNH_4/l)

The presence of ammonium in raw waters is usually associated with organic contamination (animal waste and sewage) of surface waters or from desorption of ammonium within anaerobic groundwaters. The exceedence of the indicator value in treated waters usually indicates that treatment of anaerobic groundwater or contaminated surface water has failed. The presence of ammonium in raw water may also compromise the efficiency of chlorination and therefore investigations into the exceedence of the indicator parameter value should include checks to establish the adequacy of disinfection. Unpleasant tastes and odours may be associated with high concentrations of dichloramine and trichloramine that may be caused by high concentrations of ammonium. In some cases elevated concentrations of ammonium may be associated with cement-mortar pipe linings, ingress of contaminated water or back siphonage.

(ii) Chloride (specification: 250 mgCl/l)

The presence of chloride in raw waters results from diverse inputs which include leaching from soils, sewage or industrial discharges, run-off from de-icing activities and saline intrusion. In the latter two cases there is also an associated increase in the concentration of sodium. Increased chloride content may also increase the aggressivity of water. In rare cases increases in the concentration of chloride have been associated with contamination by sodium chloride used as a regenerant for the ion–exchange removal of nitrate. Higher than normal levels of chloride may also arise from its use in domestic water softeners. Whilst these softeners should not be upstream of the kitchen tap, it is always possible that they have not been fitted in accordance with best practice. As the concentration of chloride increases above the

indicator concentration it is likely that there will be an increasing detection of taste from consumers. Typical taste thresholds are between 250 and 300 mg/l.

(iii) *Clostridium perfringens* including spores (specification: 0/100ml)

Clostridium perfringens are commonly found in human and animal faeces. As *C. perfringens* is generally present in faeces in much lower numbers than *E.coli* and enterococci, it is less sensitive as an indicator of faecal contamination. The spores of *C. perfringens* are capable of surviving for significantly longer periods than vegetative bacteria such as coliforms or enterococci. *C. perfringens* are removed from water by coagulation and filtration, but the spores of these bacteria can be resistant to chlorine at the concentrations normally used in water treatment. Low numbers may occasionally occur in water supplies, but their presence, in the absence of other faecal indicators, does not represent a risk to health. The main value of monitoring for *C. perfringens* at a point where the water leaves the water treatment works is to assess the efficiency of the treatment process. The presence of *C. perfringens* in treated water derived from groundwaters could indicate bacteriological contamination of the source. A change in the number of *C. perfringens* in treated water against the normal range for that supply is more significant than the exceedence of a particular value. Investigations into the exceedence of the indicator value should include checks to establish the quality of the source and the adequacy of treatment.

(iv) Coliform bacteria (specification: 0/100ml)

This indicator value applies only to samples taken at consumers tap – the coliform parameter at treatment works and service reservoirs are mandatory national parameters. Coliform bacteria are a diverse group which are known to be present in soil, environmental waters and other environmental materials. Some members are also capable of growth in nutrient rich water and biofilms. As a result they are not considered to be specific indicators of faecal contamination. A few members of the coliform group can be associated with human infection as opportunistic pathogens or as hospital acquired infections. Whenever coliform bacteria are isolated from a drinking water supply, investigations need to be carried out to establish the source of contamination. Coliform bacteria detected from samples taken within consumers' premises may be associated with the domestic distribution systems such as kitchen taps and sinks. Other potential sources of coliform bacteria in water supplies are sub-optimal operation of water treatment processes or ingress of contamination from breaches in the integrity of the distribution system (via hatches on service reservoirs, air valves, stop valves, cross connections and backsiphonage). In some cases additional information on the identity of the species of coliform bacteria present may prove useful in determining the sources and significance of the coliforms detected. Low numbers may occasionally occur in water supplies, but their presence, in the absence of other faecal indicators, does not represent a risk to health.

(v) Colony counts (specification: no abnormal change)

Colony counts are enumerations of the general population of heterotrophic bacteria present in a water supply. In environmental waters these represent bacteria whose natural habitat is the water environment or those that may have been washed from soil or vegetation. It is well recognised that only a small fraction of the viable heterotrophic bacteria population is estimated by enumeration on nutrient rich media with incubation at 22°C and 37 °C. However, monitoring of water supplies for

colony count bacteria can be useful for monitoring trends in water quality and detecting potential sudden deterioration in water quality. Generally the colony count at 22°C represents those bacteria naturally present in water and are not of sanitary significance. They may, however, be of greater relevance to the food and drinks industries where high numbers may impact on the quality of products. An increase in the colony count at 37°C can be a sensitive indicator of ingress in the same way as coliform bacteria therefore further investigations should be undertaken to establish the source. Colony counts may be useful in assessing the efficiency of water treatment and the cleanliness and integrity of the distribution system. In all cases the value of monitoring is to establish data which characterises a water supply in terms of seasonal and longer term changes. Drinking water supplies derived from surface waters tend to support higher numbers of heterotrophic bacteria than those derived from groundwater sources. The onset of significant change in colony count results against the normal range established for that water supply is much more significant than the absolute values of individual results.

(vi) Conductivity (specification: 2500 μS/cm at 20°C)

Conductivity is a measure of the extent of dissolved inorganic ions that are present. It is a non specific measurement although a high value may indicate undesirably high concentration of ions. Increased values of conductivity in samples taken from consumer premises may indicate potential backflow or cross connections. A change in the concentration of conductivity against the normal range for that water supply is more significant than exceedence of a particular value. Further investigation and analysis is required to identify the predominant elements present. All of the significant individual elements have either standards or indicator values against which the need for action can be assessed.

(vii) Hydrogen ion (specification: pH 6.5 - 9.5)

Hydrogen Ion (pH) gives an indication of the degree of acidity of the water. Although pH does not usually have a direct impact on consumers, it is one of the most important operational water quality parameters and can have a significant impact on the efficiency of water treatment and water quality during distribution. A low pH water can affect water treatment and may result in pipe corrosion during supply to consumers. An elevated pH may, depending on the buffering capacity of the water, increase the solubility of metals and could have an adverse impact on the aesthetic quality. Exceedence of the specification may arise as a consequence of poor acid or alkali dosing control at treatment works, from the effects of cement mortar lined pipes or from point of use treatment devices.

(viii) Sulphate (specification: 250 mgSO_4/l)

High concentrations of sulphate may affect the taste of a water supply and there is also some evidence to suggest that it may have a laxative effect in vulnerable groups such as bottle fed infants. The Regulations require water companies to take further action to investigate the origin of concentrations that exceed the indicator value. The Inspectorate recognises that there may be a few instances where the specification is regularly exceeded. In these circumstances there is little practical value in conducting repeated investigations but the company should work closely with the local Health Protection Unit of the HPA to ensure there are no risks to human health.

(ix) Total organic carbon (specification: no abnormal change)

Total organic carbon is a non specific index of the organic material in a water supply. The significance of an increase in the concentration of total organic carbon will require further investigation. In some cases the increase may be associated with increases in the concentration of assimilable organic carbon. As assimilable organic carbon provides a potential nutrient source for bacteria, water companies should investigate whether there is increased potential for the growth of biofilms.

(x) Total indicative dose (for radioactivity, specification: 0.10 mSv/year)

Where monitoring is being undertaken the level of gross alpha activity should be assessed against a screening level of 0.1 Bq/l and the level of gross beta activity assessed against a screening level of 1 Bq/l. If either screening value is exceeded additional analysis should be undertaken to establish which radionuclides are present. The range of radionuclides analysed should take into account relevant information on potential sources. The total indicative dose (TID) is then calculated from the individual isotope concentrations excluding any activity from tritium, potassium–40, radon and radon decay products. If the TID exceeds the indicator value of 0.10 mSv/year appropriate medical advice should be sought. The specification for total indicative dose is expressed in terms of the dose over a year. In interpreting the results of radioactivity monitoring it is necessary to take account of the variability in activity levels over time. Some water sources are likely to show seasonal variation due to natural processes. In addition, any short term increase in radionuclides that may result from radiological incidents should be assessed against guidance for food and liquids within guidance published by the Health Protection Agency. See also guidance on regulation 6(7) earlier in this document.

(xi) Tritium (specification: 100 Bq/l)

Tritium is naturally present in the environment but only at very low concentrations. Tritium can also be an indication of contamination from artificial sources and water companies should take actions to investigate the source of any exceedence of the indicator value. If the indicator value is exceeded additional analysis should be undertaken to establish which isotopes are present and the total indicative dose calculated from the individual isotope concentrations. If the total indicative dose exceeds the indicator value of 0.10 mSv/year appropriate medical advice should be sought. The specification for total indicative dose is expressed in terms of the dose over a year. In interpreting the results of radioactivity monitoring it is necessary to take account of the variability in activity levels over time. Some water sources are likely to show seasonal variation due to natural processes. In addition any short term increase in radionuclides that may result from radiological incidents should be assessed against guidance for food and liquids within guidance published by the Health Protection Agency. See also guidance on regulation 6(7) earlier in this document.

(xii) Turbidity (specification: 1 NTU)

The indicator value applies at the treatment works outlet. For this parameter there is in addition a mandatory maximum value of 4 NTU that applies at the consumers' tap, and where sufficient preliminary treatment is required in advance of disinfection water must not exceed 1 NTU prior to the disinfection process [see also guidance on regulation 26].

Exceedence of the indicator specification at the treatment works outlet does not in itself represent a direct risk to human health. However an elevated level of turbidity may compromise the effectiveness of disinfection. The World Health Organisation has issued guidance on the level of turbidity required to allow satisfactory disinfection. The importance of optimising the operation of water treatment works to effectively remove *Cryptosporidium* oocysts has been identified by the Expert Group on *Cryptosporidium* in water supplies. An important element of this is controlling the effectiveness of particle removal by reference to the turbidity of filtered and final waters. Any exceedence of the indicator specification at a treatment works should initiate an investigation into the cause in line with the recommendations in the reports of the Expert Groups on *Cryptosporidium* in water supplies.

27.7. A summary of investigations in respect of indicator parameters is given in Appendix 4.

28. Regulation 19 – Action by Secretary of State (in practice DWI)

28.1. The Water Supply Regulations 2010 amend regulation 19 such that the Inspectorate must proceed with an Enforcement Order under Section 18 of the Water Industry Act 1991 where the extent of any failure of a Schedule 1 parameter constitutes a potential danger to human health.

28.2. Where the failure does not constitute a potential danger to human health, then regulation 19(1) permits the Secretary of State (in practice the Inspectorate) to require water companies to seek an authorised departure if a non trivial failure of a Schedule 1 parameter is likely to recur. Authorised departures are only permitted for parameters in Table B of Schedule 1 of the regulations (chemical parameters). The Inspectorate will proceed with the making of an Enforcement Order under Section 18 of the Water Industry Act following other non-trivial failures that are likely to recur.

28.3. The Inspectorate's general policy in response to failures of national parameters (Part II of Table A and Part II of Table B in Schedule 1) is set out in Information Letter 3/2003 and the Inspectorate's enforcement policy[5]. This general policy is to continue to accept undertakings for national parameters, however undertakings can only be accepted where the supply of water in accordance with the undertaking does not constitute a potential danger to human health.

28.4. Regulation 19(4) permits the Secretary of State (in practice the DWI) to require water companies to take steps following a notification under regulation 18(2) that there is a continued inability to meet the specification of an indicator parameter. The

[5] The Inspectorate's Enforcement Policy also outlines the other enforcement options available to the Inspectorate including the use of orders, notices etc and is published on the Inspectorate's website www.dwi.gov.uk.

Inspectorate may only exercise this power where the inability to meet the specification poses a potential risk to human health.

28.5. In the event of a notice being served by a water company, under section 75 of the Act, (resulting from a notice served on it by the Secretary of State under regulation 19A), the water company must inform consumers of the remedial action that it has taken. This must include a copy of any notice that the company has served on the building owner/occupier. The nature of a public building means that the members of the public consuming water on the premises will vary. Companies are expected to take a pragmatic view as how best to ensure the effective communication of this information to consumers who may use the public building. For example the head-teacher (in the case of a school) or the building manager (of a hospital or other public building) may be best placed to ensure that appropriate advice is communicated to potential consumers. Companies should work with the building owners/occupiers or facilities management representatives to ensure that appropriate steps are taken to make consumers aware of the remedial action taken – for example publication of the notice on a public information board, or in the proximity of the main drinking water facilities.

28.6. Where the water supply from a water company is onwardly distributed by a third party then this "onwardly distributed" part (sometimes referred to as a private distribution system) comes under the Private Water Supplies Regulations 2009. Where such an arrangement supplies a public building, a failure is attributable to the domestic distribution system and the Inspectorate considers that a local authority requires information or assistance from a water company so that the Authority can enforce the requirements of the Private Water Supplies Regulations on the building owner/occupier then the Inspectorate must serve a notice requiring the provision of certain information of assistance. The Inspectorate expects that sharing of relevant information will normally form part of the discussion between Local Authorities and the water company and the need to serve such a notice would be limited to exceptional circumstances. An example of this would be where the Local Authority requires information from the water company on where the water company's network meets the private distribution system in order to identify which assets come under the Private Water Supplies Regulations, but such information has not been made readily available or communication channels have broken down preventing resolution of the drinking water quality issue.

29. Regulation 19A – Failure attributable to domestic distribution system where water is supplied to the public

29.1. The Water Supply Regulations 2010 introduce new regulation 19A which specifies the response required where a failure of a Schedule 1 parameter or a Schedule 2 (indicator) parameter is attributable to the domestic distribution system in a premises where water is supplied to the public (commonly termed a "public building"). The amendment places a duty on the Inspectorate to ensure that, in certain circumstances remedial action is taken to prevent recurrence.

29.2. The Inspectorate has sponsored research into the extent of public buildings in England & Wales the findings from which were summarised in Information Letter 10/2004 which includes a list of the types of premises and establishments and estimated numbers in each category. Water companies are required to include public

buildings in their random sampling programme and identify these in their monthly compliance data returns through the use of a data "flag".

29.3. Samples in public buildings should be taken at a tap normally used to supply water to the public or for food preparation purposes. Companies should apply the same sampling method to taps in public buildings as they do to taps in domestic premises.

29.4. If a sample taken from a public building fails to meet the concentration or value for a microbiological, chemical or national parameter, a water company must take the action required by regulation 17. Similarly for a contravention of an indicator parameter, regulation 18 must be followed. Where the company"s investigation identifies a failure is attributable to the domestic distribution system or the maintenance of that system, water companies must consider whether the problem can be adequately addressed through advice to the building occupier or owner, or if action is required by them or the building owner under the Water Supply (Water Fittings) Regulations 1999.

29.5. It is anticipated that remedial action to prevent a failure recurring can be normally be achieved through local agreement. However, under regulation 19A(1) where the Inspectorate considers any such failures to be:

- not trivial,
- are likely to recur,
- and in the case of an indicator parameter pose a potential danger to human health,

the Inspectorate must serve a notice on the water company supplying that premises (or the undertaker owning the supply system where the premises is a customer of a licensed supplier). This notice will require the undertaker to exercise its powers under section 75(2) of the Water Industry Act (i.e. it converts the undertaker's power to serve a notice into a duty to serve the notice) to ensure remedial action occurs. The requirement to comply with a notice from the Inspectorate is enforceable under section 18 of the Water Industry Act.

29.6. A section 75(2) notice served as a result of a notice under new regulation 19A must require the consumer (building owner or operator) to take the steps specified in the notice to ensure that a failure of the Water Supply (Water Quality) Regulations does not occur (or recur). If the consumer fails to take the remedial action specified in the water company"s notice then the company must take the remedial action themselves and is entitled to recover necessary costs from the consumer.

29.7. In the event of a notice being served by a water company, under section 75 of the Act, (resulting from a notice served on it by the Secretary of State under regulation 19A), the water company must inform consumers of the remedial action that it has taken. This must include a copy of any notice that the company has served on the building owner/occupier. The nature of a public building means that the members of the public consuming water on the premises will vary. Companies are expected to take a pragmatic view as how best to ensure the effective communication of this information to consumers who may use the public building. For example the head-teacher (in the case of a school) or the building manager (of a hospital or other public

building) may be best placed to ensure that appropriate advice is communicated to potential consumers. Companies should work with the building owners/occupiers or facilities management representatives to ensure that appropriate steps are taken to make consumers aware of the remedial action taken – for example publication of the notice on a public information board, or in the proximity of the main drinking water facilities.

29.8. Where the water supply from a water company is onwardly distributed by a third party then this "onwardly distributed" part (sometimes referred to as a private distribution system) comes under the Private Water Supplies Regulations 2009. Where such an arrangement supplies a public building, a failure is attributable to the domestic distribution system and the Inspectorate considers that a local authority requires information or assistance from a water company so that the Authority can enforce the requirements of the Private Water Supplies Regulations on the building owner/occupier then the Inspectorate must serve a notice requiring the provision of certain information of assistance. The Inspectorate expects that sharing of relevant information will normally form part of the discussion between Local Authorities and the water company and the need to serve such a notice would be limited to exceptional circumstances. An example of this would be where the Local Authority requires information from the water company on where the water company's network meets the private distribution system in order to identify which assets come under the Private Water Supplies Regulations, but such information has not been made readily available or communication channels have broken down preventing resolution of the drinking water quality issue.

30. Regulation 20 – Authorisation of a temporary supply of water that is not wholesome

30.1. Regulation 20 allows the Secretary of State to authorise a departure from the provisions of Part III of the Regulations upon written request of a water company. Authorised departures are only applicable for parameters in Table B of Schedule 1[6]. In practice this means authorised departures may not be granted for microbiological parameters or indicator parameters.

30.2. Authorised departures can only be granted subject to the criteria set out in regulation 20(2). One criterion is that the Secretary of State must be satisfied that the departure does not constitute a potential danger to human health. The Inspectorate will consider applications on a case by case basis and with due regard to representations made by the Health Protection Unit of the HPA which has knowledge of the local community and responsibility to advise on public health.

30.3. The information that shall be provided with an application for an authorised departure is detailed in regulation 20(3). An application form and notes on its completion are on the Inspectorate's website. Companies may submit additional information in support of their case should they so wish. Such information could include the likely maximum concentration, details of the time period of exceedence (for example if seasonal), details of any vulnerable consumers affected and the outcome of any discussions with the health authority. The Inspectorate expects companies to be actively engaged with their Health Protection Units of the HPA. They should discuss any potential

[6] The Water Supply Regulations 2010 amended regulation 20 to remove the possibility of an authorised departure being granted for microbiological parameters specified in the Drinking Water Directive.

applications with them in advance to enable any risk to the health of the communities in their care to be assessed and appropriate advice to be formulated. Equally the Inspectorate is happy to discuss draft applications with companies before the formal application is made.

30.4. The formal application must be copied to every appropriate local authority, the relevant Health Protection Units of the HPA and the relevant committee of the Consumer Council for Water, who have 30 days to make any representations on the application. In its covering letter to these bodies the companies should remind them that they have 30 days to make representation and advise them of the name of the DWI Inspector dealing with the case.

31. Regulation 21 – Authorisations: terms and conditions

31.1. Where the Secretary of State (in practice the DWI) considers that the failure to meet the prescribed concentration is trivial and that the PCV will be met within 30 days a shortened application as specified in regulation 21(4) is required.

31.2. An authorised departure may be granted for a maximum of three years and in each case will specify the extent to which any parameter may depart from the PCV specified in Schedule 1. In line with the Directive, the Inspectorate‘s approach will be to issue departures for as short a period as is reasonably required to complete the associated programme of work. The Inspectorate‘s general view is that in all cases it will be possible to restore a wholesome water supply within three years. In general, long term schemes, such as distribution system programmes, are being dealt with through undertakings.

31.3. Regulation 21(5) allows the Secretary of State to authorise a further departure again for up to a maximum period of three years. It is only envisaged that this provision will be used in exceptional circumstances. A third departure can be granted under regulation 21(7) but only with the approval of the Commission.

31.4. Regulation 23 allows the normal route for advertising authorised departures to be the placing of relevant information on the water company’s website as opposed to placement of notices in local newspapers.

PART VII – WATER TREATMENT

32. Regulation 26 – Disinfection and other treatment arrangements

32.1. Regulation 26 requires all water supplied for regulation 4(1) purposes to be disinfected. Where necessary the water also has to be subject to sufficient preliminary treatment. The point at which water is considered to be supplied for regulation 4(1) purposes is when it leaves the treatment works (regulation 26(5)(c)).

32.2. Disinfection is explicitly defined in regulation 2 (see earlier section) and sufficient preliminary treatment is also defined in regulation 26(5)(b) – see below.

32.3. The choice of treatment and disinfection processes is not specified in the regulation; this means that companies are free to decide on the most appropriate technology to apply at each treatment works. However the Inspectorate expects companies to have in place a water treatment policy and a disinfection policy covering all of the requirements of regulation 26. Both design and operation must be covered by this policy which should be kept under regular review and be informed by appropriate studies and technical performance data. The Inspectorate also expects there to be documentation and procedures in place which ensure that at every treatment works it is unambiguous how regulation 26 is being met both in principle and in practice.

32.4. Regulation 26(5)(b) defines the preliminary treatment that companies must have in place to prepare water for disinfection. This means that companies must treat the water to modify its quality in respect of any properties (e.g. pH) and substances (e.g. ammonia) known to adversely affect the performance of the disinfection process (or processes). Where no preliminary treatment takes place the Inspectorate expects the company to be able to demonstrate from robust data why no preliminary treatment is required.

32.5. The regulation makes it clear that the preliminary treatment must secure that turbidity in the raw water is reduced to below 1 NTU before water enters the disinfection stages of treatment. The Inspectorate considers that this requirement means that as a minimum, companies should have a turbidity monitor installed at a point before water enters any inactivation process such as UV or chlorine. Where this is not the case (e.g. simple ground water source where turbidity in the source water is always reliably well below 1 NTU) then the Inspectorate will interpret the readings from the final water turbidity monitor as if this was measuring the turbidity before it entered the disinfection process. It is for companies to decide whether they are content to rely just on the measurements of a single final water turbidity monitor to demonstrate compliance with regulation 26. Regardless of the location of the designated turbidity monitor(s), companies are expected to have alarms in place so that appropriate corrective action can be taken well before the measured value reaches 1 NTU.

33. Regulation 26(1A)(a) – Minimisation of disinfection by-products

33.1. The Water Supply Regulations 2010 update regulation 26(1) and require water undertakers and combined licensees to ensure that disinfection by-products (DBPs) are kept as low as possible without compromising the effectiveness of the disinfection process.

33.2. Companies should focus their activities to minimise the formation of disinfection by-products on identifying and removing DBP pre-cursers and avoiding conditions that encourage the formation of DBPs (whilst ensuring disinfection itself is not compromised).

33.3. The regulations set a parametric value of 100 µg/l for trihalomethanes (i.e. a group of four disinfection byproducts, namely chloroform, bromoform, dibromochloromethane and bromodichloromethane) and 10 µg/l for bromate. Furthermore, regulation 4(2) states that for water to be considered wholesome it must not contain any substance which alone or in conjunction with any other substance constitutes a potential danger to human health. Thus, while there may not be specific parametric values for DBP's other than THMs or bromate, these must not be present in concentrations that constitute a potential danger to human health.

Factors affecting the formation of disinfection by-products

33.4. Disinfection by-products are formed by the reaction of disinfectants with precursor substances. Natural organic matter (usually measured as Total Organic Carbon) and inorganic matter (bromide) are the most significant disinfection by-product precursors. All commonly used chemical disinfectants (e.g. chlorine, chlorine dioxide, chloramines and ozone) react with organic matter and/or bromide to varying degrees to form different disinfection by-products. Other types of disinfection by-products which may form include haloacetic acids, haloaldehydes, haloketones, chloral hydrate, haloacetonitriles, halogenated hydroxyfuranone derivatives, nitrosomines, chlorite, chlorate and bromate. The factors which influence DBP formation include:

- Type of disinfectant used;
- Concentration of disinfectant used;
- Concentrations of organic matter and other DBP precursors present in water presented for chemical disinfection;
- Temperature;
- pH;
- Contact time;
- Length of the distribution network.

33.5. The most commonly used disinfectants and their associated disinfection by-products are outlined on the table below. While a wide range of disinfectant by-products may be formed, the most commonly encountered disinfection by-products are trihalomethanes. However, the levels of bromate where ozone is used and chlorite/chlorate where chlorine dioxide is used as a disinfectant will need to be closely monitored to ensure that the levels do not exceed the regulatory standards or the World Health Organisation provisional guidelines values.

Disinfectant	Associated disinfection by-product(s)
Chlorine (e.g. gas, sodium hypochlorite, tablets, OSEC)	Trihalomethanes, Chloramines[7], Chlorinated Acetic Acids, Halogentated Acetonitriles, Chloral Hydrate, Chlorophenols, MX[8], bromate[9], chloropicrin, halofurans, bromohydrins
Chlorine Dioxide	Chlorite, Chlorate and Chloride
Ozone	Bromate, Formaldehyde, Aldehydes, Hydrogen Peroxides, Bromomethanes
Chloramines	Dichloramines, Trichloramines, Cyanogen Chloride, Chloral Hydrate

33.6. Further factors that can contribute to elevated levels of disinfection by-products include:

- A lack of, or poorly operated or maintained treatment process capable of removing organic matter (such as coagulation or filtration);
- Operation of treatment processes outside of their design criteria (e.g. excessive filtrations);
- Accumulation of sediments in service reservoirs or the distribution network;
- Ingress into reservoirs or distribution network.

Measures to Reduce Disinfection By-Products in Drinking Water

33.7. Actions that companies can take to minimise the formation of DBPs are listed below. This list is not exhaustive and a significant body of scientific knowledge is available on the reduction of disinfection by-product pre-cursors. Many of the activities below will also have beneficial impacts or should already be underway to ensure the safety and integrity of the water supply:

- Ensure the adequacy of the treatment process to remove organic material;
- Review of raw water intake management;
- Assessment and optimisation of the coagulation and clarification stage (if present);
- Assessment and optimisation of the filtration stage including assessment of media quantity and quality as well as optimisation of filter operations;
- Optimisation of the disinfection process to ensure that the optimum disinfectant dose is used. However, care must be taken that the disinfection process is never compromised;
- Assessment and review of disinfection chemicals used (e.g. ozone, chloramination, chlorine dioxide, UV etc);
- Implementation of a regular programme of flushing and scouring of distribution mains;
- Implementation of a regular programme of cleaning out of any clear water tanks and/or service reservoirs.

[7] If ammonium present in disinfected water
[8] 3-chloro-dichlormethyl-5-hydroxy-2(5H)-furanone
[9] Bromate is not formed where gas is used.

33.8. As part of the Inspectorate's existing role in assessing the adequacy of companies treatment and disinfection arrangements, companies will be expected to demonstrate how they comply with regulation 26(1A) through the minimisation of disinfection pre-cursors and the minimisation of conditions where disinfection by-products may form.

33.9. **Companies must ensure at all times that actions taken to minimise disinfection by-product formation do not compromise the effectiveness of the disinfection process**.

34. Regulation 26(1A)(b) – Verification of disinfection

34.1. The Water Supply Regulations 2010 update regulation 26(1) and require water undertakers and combined licensees to verify the effectiveness of disinfection. The Inspectorate expects companies to be doing this part of existing operational practices as covered by the policies and procedures described above. Companies are reminded that the absence of indicator bacteria is insufficient on its own to show water has been disinfected. Companies must be able to demonstrate that the disinfection process is not only designed for the challenge present in the raw water, but also that it is operating within these design criteria – i.e. company disinfection procedures must identify all the critical control points. Companies must ensure that there is current and archived validation data for each critical control for disinfection.

35. Regulation 27 – Risk assessment

35.1. The regulation requires a comprehensive risk assessment for each treatment works and connected supply system which covers all hazards and hazardous events. These risk assessments shall be undertaken using the water safety plan approach published by WHO in the Drinking Water Guidelines 2004, taking into account subsequent updates and associated guidance manuals published by WHO. Water Safety Plans provide a means of recording the hazards and hazardous events that potentially could arise in the catchment area for the source, during treatment, within the distribution system and within building plumbing systems (up to the consumers cold water tap). The methodology requires risk to be characterised for each hazard/hazardous event using a scoring system based on likelihood and consequence criteria. Risks should be characterised before and then after taking account of the existing permanent control measures in place. The scoring method should be capable of identifying "residual risks" which require further steps of mitigation (control measures) to be put in place.

35.2. Regulation 27 removed the previous specific requirement of singularly assessing risk of *Cryptosporidium* being present in a supply. A risk assessment carried out under regulation 27 should take into consideration all substances, micro-organisms including parasites, algae and viruses and all variants which may indicate a risk exists. Companies should take into consideration all available information when assessing the likelihood of a hazard being present. For example when considering *Cryptosporidium* in treated water the analysing laboratory should report the presence of all oocysts confirmed as *Cryptosporidium* spp. irrespective of size and details of any *Cryptosporidium* like bodies present. Taking information on the number of oocysts in the 4-6µm range, together with information on other size ranges and *Cryptosporidium* like bodies the company can then assess the results to determine the risk this may indicate for a particular supply system. Where an identification which is both unusual and of a concern to the company (or consumers if they were to be

made aware), this should be reported and notified as normal to the Inspectorate. Appropriate mitigation measures to address the change in risk would also be expected to put in place.

36. Regulation 28 – Procedure following risk assessment and prohibition of supply

36.1. The information required from companies by the Inspectorate as constituting a Risk Assessment Report as specified in regulation 28(2) and (3) is set out in Information letter 07/2008. The annex of IL 07/2008 incorporates guidance notes. The format may be varied to suit the risk assessment methodology of each company however companies are advised that their reports must adequately address each of the information requirements contained therein.

36.2. The Inspectorate does not require water companies to provide updates of each risk assessment on a routine basis (e.g. annually). Instead it is the duty of each water company to keep each risk assessment under continual review and provide an updated report whenever there is any material change to risk categorisation (e.g. compliance failures or events), or completion of any specified action relating to risk mitigation (e.g implementation of a specified control measure). Any new or revised risk assessment report should be submitted electronically to: DWI_Risk_Assessment@defra.gsi.gov.uk.

36.3. The Inspectorate will confirm receipt of a risk assessment report but companies need to be aware that such confirmation will not constitute approval of the risk assessment nor will it constitute a formal notice. Although Regulations 27 (5) and 28 (4) give the Secretary of State (in practice DWI) the power to issue Notices, these are intended only for those circumstances where the Inspectorate considers that it is necessary for either a further risk assessment or review be carried out or for the company to take a particular course of action.

37. Regulation 30 – Contamination from pipes

37.1. Regulation 30 deals with contamination of the water supply by copper or lead as a result of the supply and domestic pipework. Separate guidance exists on the way in which water companies should develop their plumbosolvency (and cuprosolvency if appropriate) treatment and control strategies. The prescribed risk relates to the supply of water to any individual premises and arises when copper or lead is the major component of the service pipe.

37.2. Regulation 30(4) requires water companies to modify or replace their part of any lead service pipe when it has reason to believe that the concentration of lead at the consumer's tap exceeds 10 µg/l. Also, the water company is required to replace their part of the pipe when the owner intends to replace his own part of the service pipe and the owner has made a written request to the water company to replace its part.

38. Further guidance on the lead parameter

38.1. Companies' approach to compliance with the lead parameter should be informed by their risk assessments of water supply systems. As with all risks, these assessments should consider the control measures in place to mitigate risks. Companies should identify in their risk assessment reports where there is a residual risk associated with the lead parameter and identify appropriate mitigation as part of an integrated package of measures (for example to include measures taken by the water companies and joint local action plans with local authorities / HPUs to raise awareness in the community).

38.2. Regulation 17(9) applies to a failure of the lead standard in force at that time. On that basis the trigger for action under this regulation relates to 25µg Pb/l until 25 December 2013 at which time the standard will reduce to 10µg Pb/l. This guidance has been updated to reflect the implementation over recent years by companies of water treatment (orthophosphate dosing, pH and alkalinity control, or both) measures for plumbosolvency control. Any compliance, random daytime survey or samples taken specifically at the request of consumers (but excluding samples taken for research or operational purposes particularly those involving stagnation sampling techniques) which exceeds 25µg Pb/l at a consumer's tap should trigger the potential obligation to replace lead communication pipes.

38.3. Where a relevant sample is taken which triggers a potential obligation under regulation 17(9), the company must carry out a review of results from the zone (and related zones where treatment control measures are in place at the supplying works) to determine if the failure is an isolated one.

38.4. If it is an isolated failure, the Company must take the following action:

i. if treatment has not been consistent and is not optimised then the company must make improvements to ensure treatment is consistent and optimised. Additionally, if there is lead present in the company's pipe then it must be replaced as required under Regulation 17 (9);

ii. if treatment is consistent and optimised (or it has been determined from previous reviews that treatment was not necessary), then the isolated failure must be investigated further, as follows;

- When the failure is in a sample from a tap in domestic premises or other premises which is not a public building, no further samples are required but a comprehensive investigation should be undertaken to establish if lead is present in the pipe work belonging to the company and the premises owner. If there is lead present in the company's pipe then it must be replaced as required under regulation 17 (9). There should be auditable evidence for the conclusion reached by the company's investigation. For example if preliminary investigations are inconclusive then excavation/exposure of the company's pipework may be necessary. If the investigation concludes that there is lead in the supply pipe or the internal plumbing belonging to the owner, the consumers occupying the premises must be notified and given advice about how to protect their health.

- When the failure occurs in a sample taken from a tap in a public building the company must carry out a similar investigation to that described above, and replace the company owned communication pipe where this is lead. When there is lead pipe within the pipework belonging to the public building, remedial action must be taken to ensure there is no potential danger to the health of the public consuming the water. Companies should inform the owner of the building and remind them of their obligations under the Water Supply (Water Fittings) Regulations. Where satisfactory remedial action has not been taken by the building owner and/or water company this may result in the Inspectorate serving a notice under regulation 19A.

iii. DWI should be notified as soon as possible after each investigation is concluded of the results of the investigation and the action taken together with copies of notification of building owner and consumers (this will normally be as part of the company's monthly data return to DWI). The company should have a standard form for notifying the Inspectorate.

38.5. If the failure is not an isolated one in the zone or related zones then the company must review the plumbosolvency control treatment in place and check that it has been consistent and optimised. If treatment is not consistent or optimised then action must be taken by the company to improve the treatment and continue to monitor it and lead concentrations to ensure it is consistent and optimised. However, if plumbosolvency treatment is not practised because previous reviews have determined it is not necessary then the company will need to review all results and consider whether plumbosolvency treatment is likely to reduce the lead concentration at consumer's taps. If it is concluded that treatment is necessary then the company should install treatment, obtain a consistent dose and optimise the dose as soon as practical. No further action is required, following optimisation, unless there is a subsequent failure in the zone or related zones.

38.6. If the company concludes that treatment is consistent and has been optimised then it should carry out the investigations and actions as set out above for an isolated failure and review their findings as part of their regulatory risk assessment. Where a company's regulatory risk assessment identifies a residual risk relating to lead then companies are expected to identify an integrated package of measures to mitigate this risk (see below). Where companies are proposing mitigation measures they should take into consideration current knowledge regarding options available to them. For example, the conclusions of recent work on the effectiveness of lead pipes replacement are summarised in Appendix 5.

38.7. In the period up to 24 December 2013 companies are strongly recommended to follow the same approach as set out above for any exceedences of the future lead standard of 10 µg/l as this will be required on and after 25 December 2013.

Integrated package of measures to mitigate lead risks

38.8. For the purpose of securing funding through the PR09 process for proposals to address the risk of lead compliance issues, companies were requested to identify in their risk assessments of water supply systems where there is a residual risk associated with the lead parameter and to identify an appropriate integrated package of measures to mitigate this risk. The incorporation of this risk based approach to

managing lead issues is re-iterated in this Guidance. The Inspectorate expects all water companies to address lead issues within their regulation 28 risk assessment reports using this approach.

38.9. This package should include the following:

- Identification of high, medium and low risk supply zones in terms of consumer exposure to lead in water supplies
- Continuation of, and further enhancement to, plumbosolvency control measures, if necessary.
- Replacement of lead communications pipe and provision of customer advice as stated above on exceedances of the 10µg lead concentration.
- Opportunistic lead communications and service pipe replacement from planned work on the distribution system (e.g. when preparing pipe-work for the installation of meters)
- Work with local authorities to identify vulnerable consumers, and to identify appropriate solutions, including the replacement of lead pipes in public buildings (e.g. when refurbishment is carried out in local authority housing).
- Work with health protection teams and PCTs to identify vulnerable consumers and appropriate solutions.
- A communications and education strategy to make consumers, and other stakeholders, aware of the risk of lead in water supplies, what can be done to mitigate risk, and who has responsibility for lead pipes.

39. Regulation 31 – Application and introduction of substances and products

39.1. Regulation 31(2) prohibits, with certain exceptions, the introduction by water companies of any substance or product to water that is intended for domestic purposes as defined in regulation 4(1). The exceptions are that the product or substance, at the time of its introduction, satisfies one of the conditions in regulation 31(4) or conforms with the conditions set out in regulation 31(3).

39.2. The List of Approved Products for Use in Public Water Supply in the United Kingdom is published and updated regularly on the Inspectorate's web site which represents the definitive List of all substances and products for which approval has been granted (and thus may be introduced into a water supply system, by a water company), refused, modified, revoked or prohibited. The List also makes clear any restrictions on the use of such products that must be observed. The List additionally identifies those products (currently some treatment chemicals and filter media) which may be introduced by water companies through regulation 31(3) where the product or substance conforms to a European Standard (BS:EN), subject to any national conditions of use to protect public health.

39.3. It is the responsibility of the end user, i.e. the water company or their appointed agents, to ensure that products used by them in the production, supply and distribution of drinking water are appropriately approved, under regulation 31(4)(a), or meet the requirements of regulation 31(4)(b) or (c) before introducing them to the water supply.

39.4. For those products conforming to a BS:EN, which may be used under regulation 31(3), the end user, i.e. the water company or their appointed agents, should ensure that the product they are using conforms to the requirements of the relevant BS:EN standard. The existence of a relevant BS:EN standard does not necessarily mean that all supplies of a specific treatment chemical or product will have been tested and shown to meet the appropriate requirements of the BS:EN. Thus it is the responsibility of the end user (the water supplier or their appointed agents) of these products to ensure that the treatment chemicals or products provided by a specific supplier fully meet the requirements of the relevant BS:EN standard. This can be done by obtaining, for example, a statement of conformity for the batch of chemical supplied, or by internally checking through their laboratories. Water companies should be aware BS:EN standards for drinking water treatment chemicals and products, do not contain mandatory requirements for attestation of conformity.

Full guidance on regulation 31 matters is available separately on the Inspectorate's website (www.dwi.gov.uk). This also gives additional guidance on when approval is not required before introduction of a product because it is likely to satisfy regulation 31(4)(b), or when it may be introduced for research purposes (with prior notification and for a limited period) under regulation 31(4)(c).

Approval, revocation, prohibition and charging.

39.5. Regulation 31(5) authorises applications for approval to be made by any person. Regulation 31(6) provides for variation or revocation of an approval, subject to the requirements of regulation 31 (10) and (11) in respect of the giving of notice to those affected by the variation or revocation. Regulation 31 (8) provides for the Secretary of State to prohibit the use of any substance or product which water companies would otherwise be authorised to use, subject to the requirements to give notice as set out in regulation 31 (10) and (11). Regulation 31 (13) permits the Secretary of State to make an administrative charge on the person making an application for approval of a product under regulation 31(4)(a).

40. Regulation 32 – Use of processes

40.1. Regulation 32 provides for the Secretary of State to give notice to a water company, requiring them to make an application for approval of any process. The notice may also prohibit use of the process for a specified period. Regulation 32 also provides for attaching conditions to an approval and for revocation of approval and modification of conditions of approval and publication of a list of approved processes. Provisions equivalent to those prescribed in regulation 31 in respect of giving notice apply to regulation 32.

41. Regulation 33 – Offences

41.1. Under regulation 33 a water undertaker or combined licensee who contravenes regulation 26(1), 26(3) relating to disinfection and treatment arrangements, or the terms of a notice under regulation 28(4)(d) is guilty of an offence. Water undertakers and combined licensees have a statutory defence if they are able to show that it took all reasonable steps and exercised all due diligence to avoid committing the offence.

41.2. Under the offences provisions of regulation 33, penalties are specified for contravention of: regulation 31(2) (use of unapproved products); 31(8) (contravention of a prohibition notice); 32(1) (use of a process in contravention of a prohibition notice); and 32(2) (failure to observe conditions of approval of a process).

41.3. Regulation 33 provides also for prosecution of anyone providing false information in support of an application under regulation 31 or 32. Proceedings for the offence providing false information in this manner can only be instigated with the consent of the Secretary of State (in practice the Chief Inspector of Drinking Water) or the Director of Public Prosecutions.

PART VIII – RECORDS AND INFORMATION

42. Regulation 34 – Maintenance of records

42.1. Regulation 34 details the information that the company must record and make available to the public on request. It is no longer necessary for a company to provide access to the public record at its offices. The public record may be in hard copy or electronic format. The entries for the results of compliance analysis should be reported in the units of the Regulations.

43. Regulation 35 – Provision of information

43.1. Regulation 35 (1) now requires a company to send any person a copy of the regulation 34 record within 7 days of receipt of a request. This amendment enables a company to provide public record information either by post, email or through their website. Regulation 35 (5) requires the company to notify consumers of their rights under regulation 35 (1) every year through the billing process.

43.2. There is no longer a requirement to provide local authorities with a report on the results of analysis of samples taken from water treatment works, service reservoirs, supply points and water supply zones that relate to the quality of water supplied to premises in the local authority's area. However companies are expected to consult with their respective local authorities with a view to determining what information they wish to receive in the future, over and above that contained in the Inspectorate's annual regional report.

43.3. In order to fulfil their obligations under regulation 36(6) water companies are expected to keep their contact arrangements with external organisations under continual review, particularly in respect of 24 hour (out of hours) contact details. Water companies are advised that the regulations intend that their point of contact at the local Health Protection Unit(s) of the HPA is the Consultant in Communicable Disease Control (CCDCs). Whilst it is for the HPA to have in place arrangements to inform other parts of the health service, water companies are free to make local arrangements to communicate with other person(s) within the health service. However DWI advises caution about such local arrangements because experience has shown that multiple points of contact can result in misunderstandings and poor communications.

43.4. In the context of discussing matters relating to drinking water quality it should be kept in mind that the nature of these communications will involve the exchange and interpretation of technical information. Therefore these communications are most effective when they are conducted between professionals - a CCDC and a senior public health or water quality scientist (for the water company). Further guidance is also given in the joint DWI/HPA publication Drinking water safety - a guide to health and water professionals on the Inspectorate's website. If a water company is concerned about the public health communications during any notified event they should seek assistance from the Inspectorate. Companies should bear in mind that the role of the Inspectorate in any event which threatens to become an emergency is as the appointed technical advisor to the Secretary of State.

44. Regulation 36 – Publication of information

44.1. Regulation 36 of the original 2000 Regulations has been revoked with the effect that companies are no longer required to publish an annual report about drinking water quality.

APPENDIX 1: REGULATION 16 – ANALYSIS OF SAMPLES

A1 Training of analysts

A1.1 Water companies or their analytical contractor should produce a comprehensive analyst training manual and programme to cover all aspects of analysis.

A1.2 Once trained, all analysts' performance should be monitored and subject to regular audit. Monitoring and audit procedures, criteria for satisfactory performance and policy on retraining should be documented.

A1.3 A training record should be produced for each analyst detailing the training given, with dates and assessment of competence to perform the task, results of any audits, any retraining or further training given and any re-assessment of that competence.

A1.4 Guidance on the competence requirements of analysts, their supervisors and laboratory technical and quality management required to comply with regulation 16(2)(d)(i) is given in Information letter 08/2007.

A2 Suitability of equipment

A2.1 In addition to equipment being of the type specified in the analytical procedure, it must comply with each of the following requirements before it can be regarded as suitable for the purpose:

(i) located and used in appropriate conditions;

(ii) maintained according to the manufacturer's recommendations or auditable equivalent procedures;

(iii) have a current calibration that is both valid and traceable to national and international standards;

(iv) be used in accordance with the manufacturer's operating instructions or auditable equivalent procedures; and

(v) demonstrably comply with all system suitability and analytical quality control criteria.

A2.2 General advice on calibration is given in 'Guidelines for Calibration in Laboratories' which is available on the DWI web site (www.dwi.gov.uk).

A2.3 Sub-paragraph (e) of regulation 16(2) requires that all analysis, including field tests, must be subject to a system of analytical quality control (AQC) sufficient to demonstrate that the requirements of regulation 16(5) have been complied with for each analysis. For microbiological parameters either the specified method or an approved alternative must be used in conjunction with the practices and procedures given in 'The Microbiology of Drinking Water (2002)'.

A2.4 Appropriate systems of AQC for all other parameters will include:

- Performance testing of the analytical system;

- Routine internal AQC; and

- External AQC (proficiency testing), if a suitable scheme is available.

A2.5 Sub-paragraph (e)(ii) of regulation 16(2) requires that a laboratory's system of AQC is subject to independent checking by a person who has been approved by the Secretary of State for that purpose.

A3 Initial Performance testing

A3.1 Each laboratory or field testing organisation is required to have tested the performance of the analytical methods used for each parameter or each determined constituent of a parameter, and to have demonstrated that the system is capable of meeting the requirements set out in paragraph 16(5) and Schedule 4 before that system is used for routine analysis of compliance samples. Performance testing should cover the entire analytical procedure, including any sample preparation and concentration steps. Testing must be carried out in a manner emulating that used routinely, without taking special precautions which would not generally apply to achieve optimum performance.

A3.2 An analytical method is the specific combination of laboratory, analysts, instrumentation and analytical procedure used to analyse the sample, including any sample preparation or pre-treatment steps. Provided all analysts have been trained to the same standard and their competence has been assessed using the same criteria they can be regarded as equivalent for the purposes of initial performance testing of the analytical method.

A3.3 The analytical method should be subjected to testing of its trueness, precision and limit of detection, including spiking recovery and resilience against possible interferences. The minimum acceptable specifications for performance testing are given below. The design of tests and calculation of performance characteristics should be in accordance or consistent with the guidance given in 'A Manual of Analytical Quality Control for the Water Industry'(NS30).

A3.4 A laboratory using an analytical method which is not referenced to a fully validated authoritative method will be expected to demonstrate that the method has been fully documented and tested to the standard currently expected of an authoritative reference method. It should demonstrate that the following have been established:

(i) the required tolerances of all measurements undertaken within the method (volumes, temperatures, masses etc);

(ii) the forms of the determinand measured, including speciation;

(iii) the effect of interferences has been widely investigated and quantified; and

(iv) significant sources of error have been identified and adequate means of controlling them documented.

A3.5 Further guidance is given in section 4 of NS30. In the past some reference methods may have been validated to a lower standard than is now required by bodies such as the Standing Committee of Analysts. The data available plus the body of experience of use of these methods should be assessed when deciding whether the methods are suitable.

A3.6 For most parameters the minimum specification for the performance characteristics to be determined is as follows.

Estimate the within-laboratory total standard deviation of individual analytical results for blanks, standard solutions, samples and spiked samples on at least 5 separate days (further advice on number of batches and period of testing is given below). The number of replicate determinations of each solution in each batch should be the same and not less than two. The trueness for standard solutions, mean spiking recovery and standard deviation of spiking recovery should also be determined.

A3.7 The range of the standard solutions tested should include the regulatory prescribed concentration or value wherever possible, but in all cases the whole calibrated range of the method must be covered subject to allowance for ensuring that all measurements fall within the calibrated range. This implies that a minimum of two different standard solutions must be included in the performance tests. All standard solutions should be prepared immediately prior to analysis for each batch, either from the pure substance or a stock solution which is known to be stable for the period of the tests.

A3.8 All estimates of standard deviation used to estimate limit of detection or precision, or used in significance tests must have at least 10 degrees of freedom.

A3.9 The sample, or, if necessary, samples, and spiked sample(s) selected for use should represent the type or types of drinking water normally analysed. The same bulk sample(s) should be used throughout the tests. Samples should be spiked immediately before analysis for each batch. The spiking standard should either be known to be stable for the period of the tests or be prepared as for standard solutions.

A3.10 Where there is a choice of key instruments, including electrodes and chromatographic columns, each combination used should be regarded as a separate analytical method. In such cases the following guidance is given.

A3.11 For identical instruments full validation is required of each method except where the results of limited testing of the instruments under the conditions used in the analytical method have demonstrated that there is no statistically significant (at the 95% confidence level) difference in performance between the instruments, in which case only one method requires full validation. The tests should be performed on a minimum of five separate days and include the analysis of typical real samples and spiked samples. If the internal AQC record subsequently shows a significant difference in performance between methods each system should then be fully validated. Alternatively, independent data may be available to demonstrate the equivalence of items such as chromatographic columns.

A3.12 For instruments which are not identical full validation is required for each analytical method.

A3.13 Laboratories should note that 5 batches of duplicate analyses does not give 10 degrees of freedom. While many combinations of number and size of batch may give 10 degrees of freedom or more, a minimum of 11 batches is required to guarantee that number of degrees of freedom, irrespective of the number of replicates included in the batch. Laboratories are therefore strongly recommended to adopt 11 batches of duplicates as their minimum specification. The formula for calculating degrees of freedom is given on page 57 of NS30.

A3.14 For methods where the discrimination of the method is insufficient to record values other than zero for most blank determinations the within-batch standard deviation of either the low standard or the within-batch standard deviation of the sample may be used to calculate the limit of detection. Alternatively, a very low standard solution, at a concentration approximately two to three times the expected limit of detection when using the best currently available method, may be used as a surrogate blank. Similarly a natural sample spiked at a similar low level may, if necessary, be used as a surrogate natural sample. Some methods, particularly those involving simple titrations or the use of comparators, may be incapable of measuring any within-batch differences. In such cases the limit of detection should be quoted as the lowest measurable concentration or value.

A3.15 The bulk sample may not always be stable over the entire period of testing, resulting in an artificially high estimate of between-batch standard deviation. This instability may be recognised by a distinct trend in results for the sample over the period of testing and a between-batch standard deviation which, statistically, is significantly greater (at the 95% confidence level) than would be expected from the estimates obtained for the standard solutions. In such cases a surrogate between-batch standard deviation should be calculated using procedure (a) on page 53 of NS30. Where the instability is so great that the estimate of within-batch standard deviation is significantly affected it may be possible to improve stability by ageing of the sample. Where ageing is either impractical or ineffective in reducing sample instability sufficiently to avoid a statistically significant effect on the estimate of within-batch standard deviation, procedure (b) on pages 53 and 54 of NS30 should be used.

A3.16 The period of testing should be continuous and not unduly long. Not more than 2 batches may be analysed on any one day. When 2 batches are analysed on the same day all instruments used should be shut down to overnight conditions, daily reagents freshly prepared and all test solutions freshly prepared between the first and second batches.

A3.17 For physical parameters for which values are not truly additive spiking recovery tests may yield little useful information and need not be done. It is not possible to either analyse a blank or do spiking recovery tests for hydrogen ion. For these parameters the calibrated range (or ranges) must include the full range of values encountered and the PCV (the full PCV range for hydrogen ion), as samples cannot be diluted.

A3.18 In the following paragraphs re-evaluation means the investigation of the analytical system and its performance to determine whether the most recent validation or revalidation of the analytical system remains appropriate. Re-evaluation may include, as necessary, assessment of the cumulative effect of minor changes to the analytical method, review of internal and external AQC and corrective action followed by limited testing to demonstrate that correct performance has been re-established.

A3.19 In the following paragraphs revalidation means the redetermination of the performance characteristics of the analytical system as described above.

A3.20 The performance characteristics of an analytical method should be revalidated whenever a significant change has occurred such as a change in:

(i) the analytical procedure used;

(ii) the key equipment used;

(iii) the laboratory environment; or

(iv) change of staff carrying out the procedure. This does not include routine changes which normally occur within the laboratory which are supported by appropriate training and properly trained supervisors.

A3.21 The significance of any change should be assessed by a competent analyst, and any decision that a change is not significant supported by the results of limited but adequate testing.

A3.22 When a change of premises occurs it is not always possible to revalidate all analytical methods before they are used. In such cases it is essential that methods which on transfer also undergo a change of one of the types (i), (ii) and (iv) above are revalidated before they are used, as should those which are known to be susceptible to changes in laboratory environment e.g. ammonium and trihalomethanes. Other analytical methods should normally be revalidated within 3 months of relocation.

A3.23 Analytical methods should also be re-evaluated and if necessary revalidated whenever the results of routine AQC (internal or external) indicate that a statistically significant deterioration in performance has occurred which cannot be corrected, or that there is a significant discontinuity in the routine AQC record, whether due to a failure to perform routine AQC or disuse of the analytical method. Laboratories may also wish to re-evaluate the performance characteristics whenever routine AQC indicates that a statistically significant improvement in performance has occurred. Statistical significance should normally be assessed at the 95% confidence level.

A3.24 Analytical methods which are used infrequently should not require full revalidation when they are used provided a greater degree of internal AQC is employed than that recommended for routinely used systems. A suitable procedure is given in recommendation (iv) of the Harmonised Guidelines for Internal Quality Control in Analytical Chemistry Laboratories ISO/IUPAC/AOAC, Pure and Applied Chemistry, vol 67, No 4, pp 649-666, 1995 (The AQC Guidelines).

A3.25 When an analytical method has been in continuous use for several years, typically between 3 and 5 years without revalidation, the system should be re-evaluated, and the need for revalidation of the performance characteristics considered.

A4 Routine Internal AQC

A4.1 As a minimum, the laboratory should use a control solution that contains a known concentration at or close to the PCV for each parameter or determined constituent of a parameter for each analytical method, except as provided for below. The term "close to the PCV" should be interpreted as meaning the PCV ± 25%. The PCV for a determined constituent of a parameter is the PCV for the parameter. The frequency of use of control solutions must be at a frequency of >5% of samples and subject to a minimum of one per batch of analyses for batches of less than 20 samples. All control solutions should be subject to the full analytical procedure that is used for analysing samples and analysed with each batch of analyses.

A4.2 For permanent laboratory tests a "batch of analyses" should be regarded as a group of measurements or observations of standards, samples and/or control solutions which

have been performed together in respect of all procedures, either simultaneously or sequentially, by the same analysts using the same reagents, equipment and calibration.

A4.3 For field tests a "batch of analyses" should be regarded as a group of measurements or observations of standards, samples and/or control solutions which have been performed on the same day by the same analysts using the same reagents, equipment and calibration.

A4.4 In the following cases the guidance on selection of control solutions given above is not appropriate:

(i) the PCV represents a concentration or value outside the normal analytical range of a particular method;

(ii) there is no PCV;

(iii) the PCV is descriptive;

(iv) the PCV is a minimum; or

(v) the PCV is a range.

A4.5 In these cases, as a minimum, a control solution with a known concentration or value within both the calibrated range of the method and the range of interest should be used.

A4.6 When a wide range of concentrations or values is calibrated which includes the PCV but the overwhelming majority of drinking water samples have concentrations or values which are within a narrow band of the calibration range for which control at the PCV is inappropriate, as a minimum two control solutions should be used, one with a known concentration or value at or close to the PCV and the other with a known concentration or value within the range of interest.

A4.7 As a minimum, all the results obtained from all control solutions should be used to plot, for each solution or calculated quality control characteristic, a Shewhart chart which is used to decide whether a method is in statistical control. When other types of chart are used, including those using statistics calculated from individual values, the laboratory or other organisation should demonstrate that its arrangements effect adequate statistical control over the systematic error, and both the within-batch and between-batch components of random error, though not necessarily as separate items.

A4.8 Further guidance on the construction and use of control charts is given in NS30, the AQC Guidelines and “Guidance on the Interpretation of Aspects of Analytical Quality Control (AQC)” which is available from the Drinking Water Inspectorate.

A4.9 The laboratory or other organisation should have properly documented policy and procedures for routine AQC that stipulate what action or actions should be followed when an out of control condition is shown to exist, include a definition of an out of control condition and detail the records to be made when such a condition exists. These documents should be consistent with the guidance given in the documents referenced above. The results of analyses obtained using a method not in statistical control should not be released except in exceptional circumstances, when each result so released should carry an appropriate commentary in all records and reports. The circumstances in which such results can be released should be fully documented and state that the cause of the out of control condition should first be identified and shown not to affect the results of analysis of samples intended for release.

A4.10 The procedures should also include regular and frequent examination and review of all charts and include guidance for checking and investigating significant trends or changes in either random or systematic error, and for correct operation of the chart. The minimum examination and review periods for each chart should depend on the frequency with which datum points are produced but should not be less frequent than monthly for examination and annually for review. The examination and review should be carried out by a suitably qualified and competent person who is not directly involved in the analysis, such as the laboratory quality manager. There should be appropriate rules for assessing revised control limits.

A5 External AQC

A5.1 The laboratory should participate in an appropriate external AQC scheme for each parameter or determined constituent of a parameter for which an appropriate scheme is available. The laboratory should also have a properly documented procedure for investigating and recording all failures notified by the organiser of a scheme.

A5.2 Guidance on the suitability of a scheme is given in "The International Harmonised Protocol for the Proficiency Testing of (Chemical) Analytical Laboratories" M Thompson, R Wood, Journal of AOAC International, Vol 76, No 4, 1993.

A5.3 In line with the recommendations of this document laboratories are recommended to participate in schemes distributing drinking water samples of appropriate matrix and which conform to the relevant parts of the protocol. Samples should contain or be spiked with concentrations of interest (approximate range PCV/10 to twice the PCV) and with appropriate speciation where this is of interest. When, in respect of any parameter, a laboratory participates only in schemes which do not meet all the recommended criteria it will be expected to demonstrate that it is participating in the most appropriate scheme currently available.

A6 Regulation 16(3)

A6.1 This regulation includes any organisation or person carrying out regulatory analysis in the definition of a laboratory. This includes all analyses carried out as field tests. Advice on the use of on line monitors is included above at paragraphs 19.13-19.19.

A7 Regulation 16(4) Retention of records

A7.1 This regulation requires a water company to make and retain all records necessary to establish that all the requirements of regulation 16 have been complied with in respect of each analysis carried out.

A7.2 The records required include:

(i) instrument installation, commissioning, maintenance and repair records, including any instrument log or diary;

(ii) basic calibration records (including proof of traceability), system suitability checks and any other record necessary to demonstrate the suitability of any equipment used at the time of the analysis;

(iii) the analytical procedure used;

(iv) method performance testing data, including raw data and a full record of any re-evaluation of the method;

(v) routine internal and external AQC data, including charts, investigations of out of control conditions and corrective action; and

(vi) raw data for the whole analytical run.

A7.3 Items (i) and (ii) above should be retained for not less than three years after the equipment has been decommissioned and disposed of. Calibration records should be retained for not less than three years after either disposal of the equipment or disposal of the calibration item, whichever is the longer.

A7.4 Items (iii) and (iv) above should be retained for not less than three years after the last analysis to which they relate.

A7.5 Items (v) and (vi) above should be retained for not less than three years.

A8 Regulation 16(5)

A8.1 This regulation sets the required standard for quality of analysis or, in the case of microbiological parameters, the method to be used.

Microbiological parameters

A8.2 Sub-paragraph (a) requires that the methods specified in column (2) of Table A1 in Schedule 4 must be used, unless an alternative has been approved. See regulations 16(7) to 16(11) below.

Hydrogen ion

A8.3 All pH measurements must have a trueness of 0.2 pH units and a precision of 0.2 pH units. Suitability of any analytical method used must be established before it is used to analyse samples. See *Initial performance testing* above. On commencement of use, the analytical method must then be continuously subject to routine internal and external AQC. See *Routine Internal AQC* and *External AQC* above.

Odour and Taste[10]

A8.4 A method with a precision of 1 dilution number at 25°C must be used.

A8.5 Methods A1-A3 respectively in the publication The Determination of Taste and Odour in Drinking Waters (2010) in the series Methods for the Examination of Waters and Associated Materials should be used. Performance characteristics cannot be determined for these parameters, nor is there currently available a suitable scheme of external AQC. One sample, which is expected to have a dilution number greater than zero, should be analysed in duplicate with each batch of samples put through the full procedure. The difference between the two results should be plotted on a control chart and used to provide information precision of analysis of samples. All out of control conditions should be investigated and appropriate action taken. Further advice on the use of difference control charts is given in section 5.3.3 (pages 59 to 70) of NS30.

Parameters with no PCV or a descriptive PCV only

A8.6 The parameters residual disinfectant (free and/or total chlorine) and total organic carbon have no numerical value for the PCV and therefore do not appear in Table 2 in Schedule 4. The general guidance given below for all other parameters is appropriate, but satisfactory target values for limit of detection, precision and trueness need to be set by the laboratory. This should be done on the basis of fitness for purpose. Unless the water company is able to demonstrate that less stringent targets are appropriate the target values given below will be regarded as describing fitness for purpose for these parameters.

(i) Residual Disinfectant:

Trueness	The greater of 10% of the result or 0.05 mg Cl/l
Precision	The greater of 10% of the result or 0.05 mg Cl/l
Limit of Detection	0.05 mg Cl/l or the minimum concentration specified as either a target value or an action level at any of the water company's treatments works or in its distribution system, whichever is the lower concentration.

Guidance on calibration and AQC for chlorine measurement is given in Information letter 03/2005 .

(ii) Total organic carbon (TOC)

Trueness	The greater of 10% of the result or 0.25 mg C/l
Precision	The greater of 10% of the result or 0.25 mg C/l
Limit of Detection	0.5 mg C/l

All other parameters

A8.7 The performance requirements are given in Table A2 in Schedule 4 in terms of the maximum permitted deviation of the method for trueness and precision and the maximum value for the limit of detection. These terms are defined in regulation 16(6). For the purposes of these regulations, the precision quoted is numerically equal to twice the total within laboratory standard deviation of individual results.

A8.8 Methods that measure the parameter as defined and are capable of achieving the stated performance should be selected. Due regard must be given to the effect of interferences. In general, the methods published by the Standing Committee of Analysts in the series 'Methods for the Examination of Waters and Associated Materials' will be capable of the required performance, but laboratories should ascertain this before using any particular method.

A8.9 A laboratory using an analytical method which is not referenced to a fully validated authoritative method will be expected to demonstrate that the method has been fully documented and tested to the standard currently expected of an authoritative reference method. It should demonstrate that the following have been established:

(i) the required tolerances of all measurements undertaken within the method (volumes, temperatures, masses etc);
(ii) the forms of the determinand measured, including speciation;

(iii) the effect of interferences has been widely investigated and quantified; and

(iv) significant sources of error have been identified and adequate means of controlling them documented.

A8.10 Further guidance is given in section 4 (pages 31 to 48) of NS30. In the past some reference methods may have been validated to a lower standard than is now required by bodies such as the Standing Committee of Analysts. The data available plus the body of experience of use of these methods should be assessed when deciding whether these methods are suitable.

A8.11 Table A2 in Schedule 4 only specifies precision and trueness at the PCV. At other concentrations or values the requirement is either the percentage figure given in Table A2 or one half of the value or concentration represented by that percentage figure at the PCV, whichever is the larger.

A8.12 For example, for aluminium the trueness and precision requirements are 10% at the PCV (200 μg/l). This equates to an absolute value of 20 μg/l at the PCV. The target for concentrations less than 100 μg/l (one half of the PCV) is one half of this, 10 μg/l (standard deviation 5 μg/l). For all concentrations above 100 μg/l the target is 10% of the result (standard deviation 5%). At one half of the PCV the target is the same whichever way it is calculated. A worked example for bromate is given below.

Worked example for the bromate parameter

Limit of Detection

Target 25% of PCV i.e. for bromate 2.5 ug/l

Calculated as 5 x within batch SD for blank or low standard surrogate blank or 3 x within batch SD of a natural sample or low spiked sample.

Precision

Target the greater of 25% of mean result or 25% of 0.5 x PCV i.e. for bromate 25% of mean or 1.25ug/l

This applies to all solutions

Trueness

(i) Standards

Greater of 25% of true value or absolute target of 25% of 0.5 x PCV i.e. for bromate 25% of prepared value or 1.25 ug/l

(ii) Natural samples

Not applicable

(iii) Spiked natural samples
Mean recovery of spike the greater of 25% of added spike or 25% of 0.5 x PCV i.e. for bromate 25% of added spike or 1.25 μg/l

A8.13 The suitability of any analytical system used must be established before it is used to analyse samples. See *Initial performance testing* above. On commencement of use, the analytical system must then be continuously subject to routine internal and external AQC. See *Routine Internal AQC* and *External AQC* above.
Guidance on the suitability of methods for the preparation of samples for analysis of metals, sample and sample extract preservation and storage requirements is given in Information letter 12/2005.

A8.14 Performance of a method is satisfactory if either all the relevant criteria are met for all solutions or any difference between the target and the estimate is not significant at the 95% confidence interval.

A9 Regulation 16(6)

A9.1 This regulation defines the terms 'limit of detection', 'precision' and 'trueness'.

A9.2 Either of the methods of estimating the 'limit of detection' given may be used. The estimate of standard deviation used must be calculated from the initial performance testing data using ANOVA. An F-test may be used to determine whether a failure to achieve the target limit of detection is statistically significant.

A9.3 'Precision' is twice the total within laboratory standard deviation. It must be calculated from the initial performance testing data using ANOVA. An F-test may be used to determine whether a failure to achieve the target precision is statistically significant.

A9.4 'Trueness' must be determined using the calculated value of a standard solution or added spike as the true value, and the mean value calculated from the initial performance testing data using ANOVA. A t-test may be used to determine whether a failure to achieve the target trueness is statistically significant, provided precision is satisfactory.

A10 Use of Reporting Limits instead of the limit of detection

A10.1 Analytical reporting limits (RLs) are values or concentrations, other than limits of detection (LODs), that are used by laboratories, and sometimes Water Companies, as a cut off below which all results for a particular test are reported as being less than that value or concentration. They should not be used for parameters that are defined as the sum of the detected concentrations of the constituent compounds, e.g. total pesticides, trihalomethanes, polycyclic aromatic hydrocarbons.

A10.2 RLs are sometimes used instead of the determined LODs because the LOD has a value or concentration that is not compatible with the laboratory's or company's policy on reporting results because it has more significant figures than are reported. This practice is only acceptable if the RL adopted is the LOD rounded up to the last reporting figure, and the RL is only applied to the final calculated result (including any conversion to regulatory units). Examples of acceptable and unacceptable RLs are given below.

Examples of inappropriate use of reporting limits

LOD	Maximum permissible LOD	RL[1,2]	Reason given for adopting RL
0.31	2.5	2.5	Equals maximum permissible LOD and will not need revising if LOD changes
0.65	1	2	Set as a common RL for all determinands in the analysis suite

[1] Using these RLs on the public record instead of the actual result of analysis would contravene the reporting requirements.

[2] Applying these RLs to intermediate results (e.g. to nitrite and total oxidised nitrogen results before calculating the nitrate result) would contravene the requirements of regulation 16. The calculation is part of the analytical method.

Examples of appropriate use of reporting limits

LOD	Number of decimal places reported for results close to the LOD[3,4]	Appropriate RL
0.141	3	0.141
0.141	2	0.15
0.141	1	0.2

[3] The number of decimal places reported should always be related to method performance.

[4] The examples of number of decimal places reported are given for demonstration of appropriate reporting limits only and do not reflect any view on the appropriate number of significant figures to report.

A11 Regulations 16(7) to 16(11)

A11.1 Where a method of analysis is specified in Table A1 in Schedule 4, the prescribed method, laboratories must use the specified method unless an alternative method has been authorised (approved), in which case the authorised alternative may be used subject to any conditions given in the authorisation. An alternative method may not be used until written authorisation has been given to the appropriate water company.

A11.2 A laboratory wishing to use an alternative method that has not been approved must first make an application, through the relevant water company, for authorisation of the method. Such application must be made in writing to the Drinking Water Inspectorate and must include a full description of the method to be used along with results of tests demonstrating both the reliability of the method and its equivalence to the prescribed method.

A11.3 More detail of the information and testing requirements and criteria are given in 'The Microbiology of Drinking Water. An expert group of microbiologists from Member States is to be established to provide advice to the Commission on technical issues such as performance testing of alternative microbiological methods.

A11.4 An alternative method will only be authorised if it is adequately documented and the results of tests demonstrate to the Drinking Water Inspectorate's satisfaction that

results obtained using the method are at least as reliable as those produced by the use of the prescribed method.

A11.5 The Drinking Water Inspectorate may make any authorisation subject to such conditions as it considers appropriate, e.g. limitation of the types of sample matrix it may be used to analyse or specify extra quality control requirements. Authorisation may be general or granted to a specific water company. It may also be revoked at any time, by notice in writing to any water company to which authorisation has been given. At least three months notice will be given of any revocation.

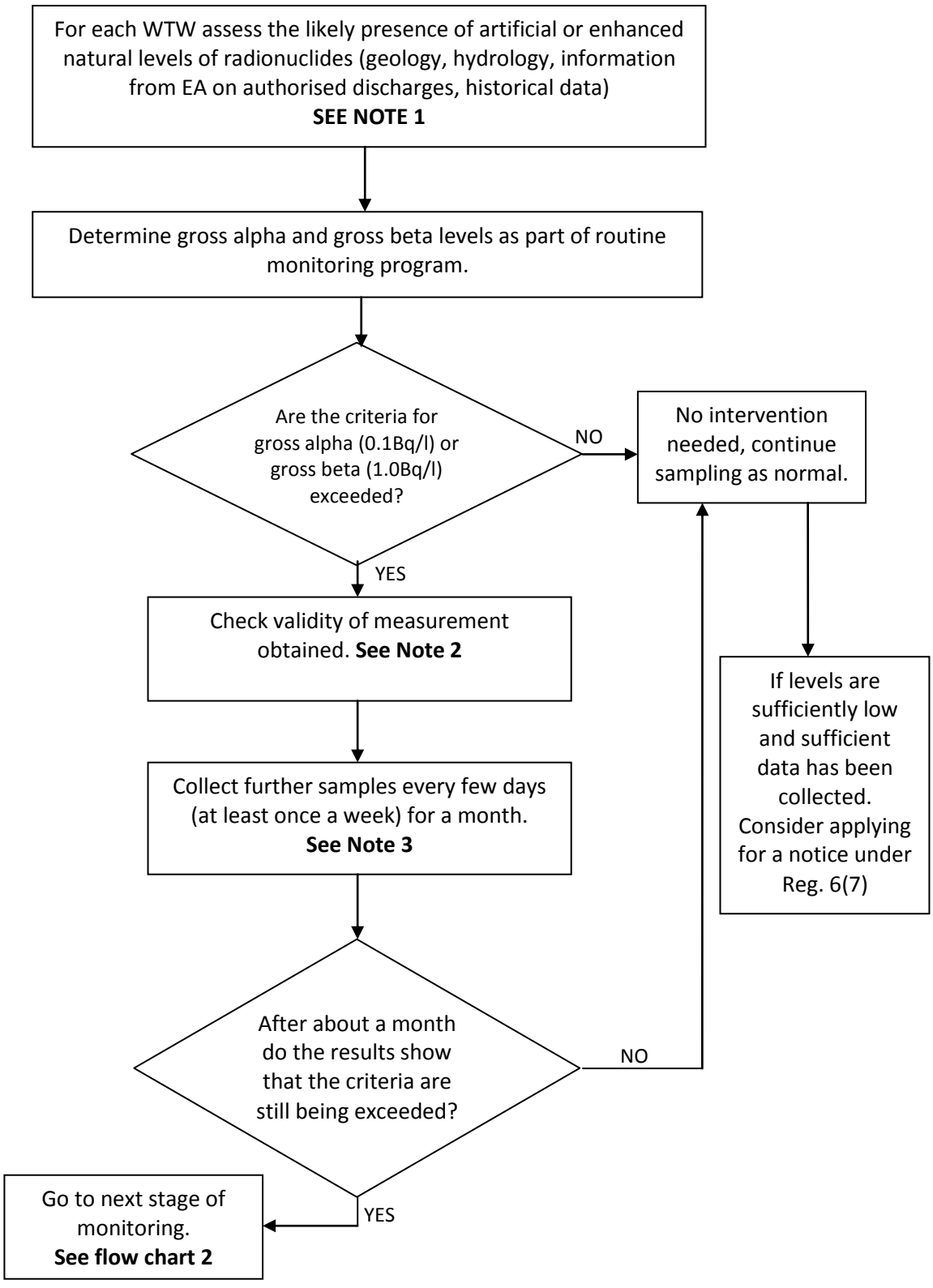
A12 Additional Information

A12.1 In addition to the guidance given above and in the documents referenced in the Annex and the Introduction to the Guidance, advice on different aspects of AQC is given in a number of other documents, many of which are referenced within the reference documents. Further sources of relevant information are:

- 'Guidelines for Calibration in Laboratories', which is available on www.dwi.gov.uk.
- 'A Manual of Analytical Quality Control for the Water Industry'(NS30).
- Harmonised Guidelines for Internal Quality Control in Analytical Chemistry Laboratories ISO/IUPAC/AOAC, Pure and Applied Chemistry, vol 67, No 4, pp 649-666, 1995 (The AQC Guidelines).
- "Guidance On The Interpretation Of Aspects Of Analytical Quality Control (AQC)"
- "The International Harmonised Protocol for the Proficiency Testing of (Chemical) Analytical Laboratories" M Thompson, R Wood, Journal of AOAC International, Vol 76, No 4, 1993.
- "The Determination of Taste and Odour in Drinking Waters 2010" in the series Methods for the Examination of Waters and Associated Materials (HMSO)
- "Quality Control Charts in Routine Analysis", Gardner M J, Water Research Centre, November 1996, WRc Ref: CO 4239
- BSi Draft for Development "Water Quality – Guide to analytical quality control for water analysis" BSi Ref: DD ENV ISO 13530:1999 (CEN Ref: ENV ISO 13530:1998 E. ISO Ref: ISO/TR 13530:1997(E)).
- "Quality Control Charts in Routine Analysis", Gardner M J, Water Research Centre, November 1996, WRc Ref: CO 4239.
- "The Microbiology of Drinking water 2002" and relevant updates in the series Methods Of Examination of Waters and Associated Materials. (http:\www.environment-agency.gov.uk/nls)

APPENDIX 2: RADIOACTIVITY MONITORING

Radioactivity monitoring flow chart – Stage 1: Initial Screening



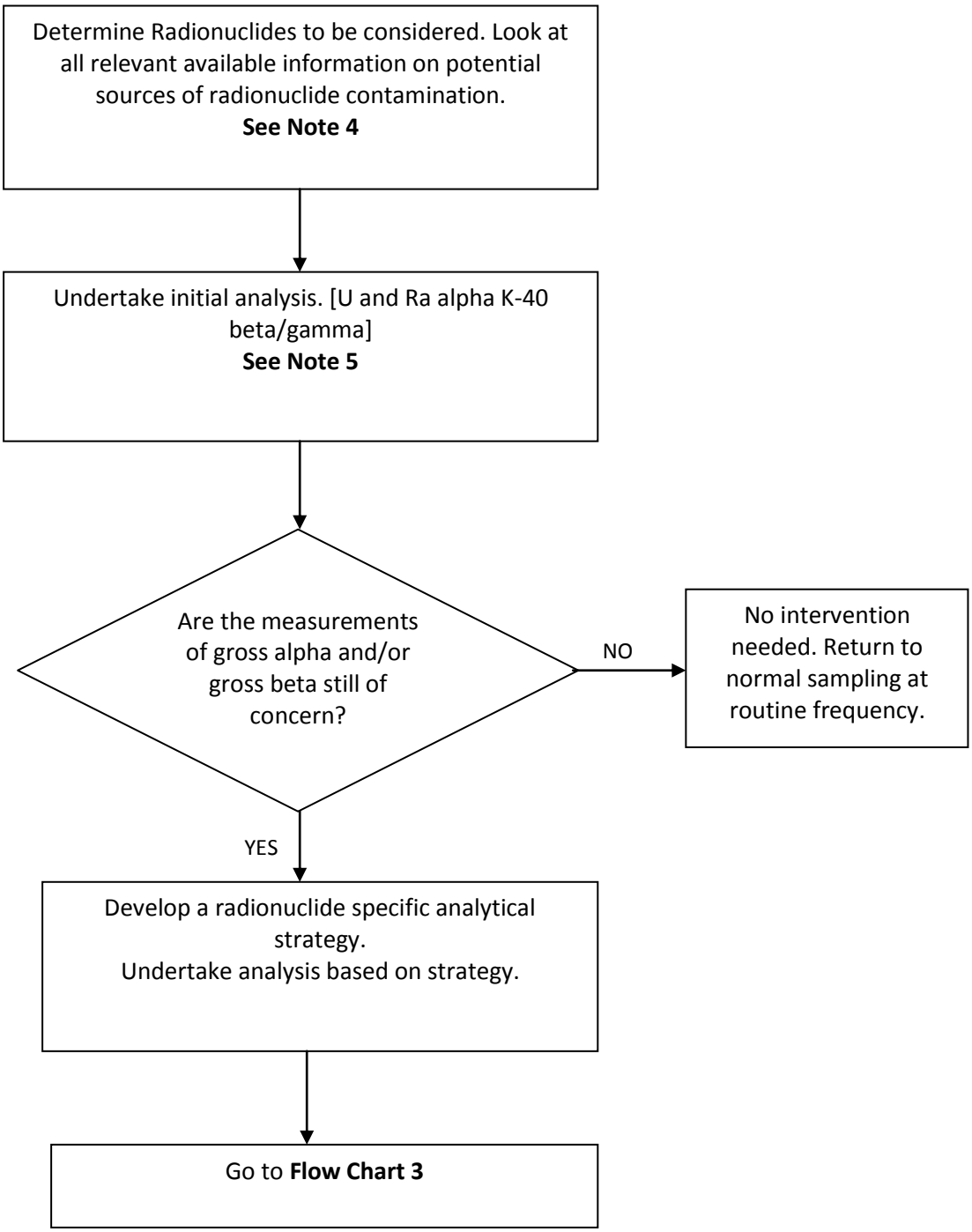
Flow Chart 1 notes

Note 1: companies' statutory risk assessments should take into account any potential radiological contamination in catchment areas. The most comprehensive source of monitoring data to facilitate this is issued annually by EA, FSA, SEPA and NIEA, this is known as the RIFE report. This information and any historical data collected by the Company may be useful when determining a strategy for individual radionuclide analysis if required.

Note 2: It is possible to use the data from other samples analysed in the same batch to demonstrate that the procedure and the measurement equipment itself are working properly. Checks on the instrument calibration and background would also be needed. If there is a sufficient amount of sample, then a repeat analysis should be carried out. [This may not be practical due to volumes of samples collected]

Note 3: The time taken to analyse samples needs to be taken into account. Collection of additional samples while waiting for validity of initial measurement would be prudent. A large volume sample should be taken to enable radionuclide specific analysis to be undertaken on the early samples if required.

Radioactivity monitoring flow chart – Stage 2 screening

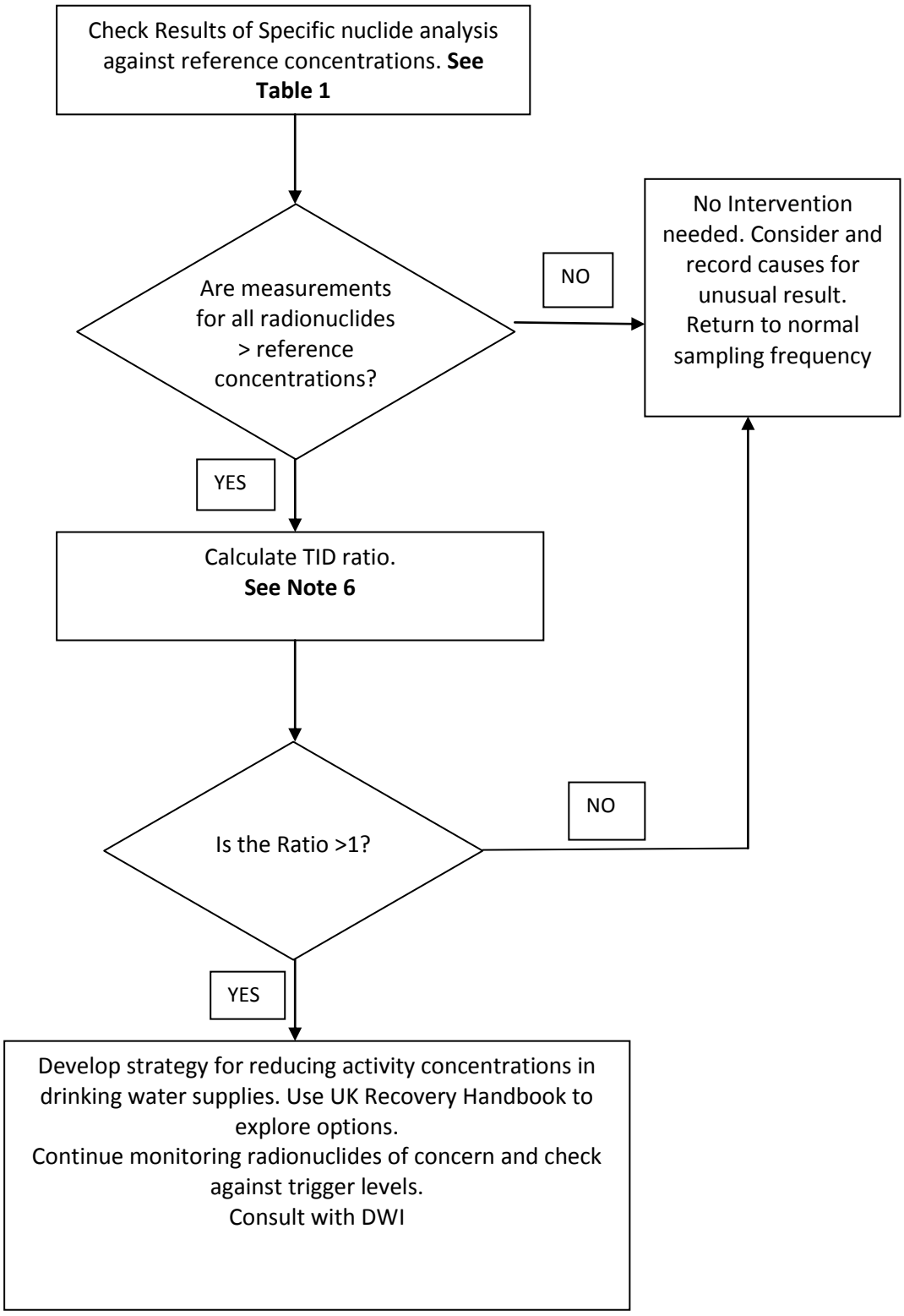


Flow Chart 2 notes

Note 4: Consideration should be given to the catchment. There are various sites across the UK, licensed to discharge small quantities of radioactivity into the environment. Check RIFE report.

Note 5: Many of the radionuclides that emit beta particles also emit gamma photons. The energy of these photons characterises the radionuclide. Consequently when the criterion on gross beta activity is exceeded, high resolution gamma-ray spectrometry provides a powerful way of determining the presence or absence of a wide range of both natural and artificial radionuclides. Potassium-40 emits a characteristic gamma proton and so the radionuclide most likely to account for exceedance of the criterion on gross beta can be determined very conveniently.

Radioactivity monitoring flow chart – Stage 3: Assessment of Total Indicative Dose (TID)



Flow Chart 3 notes

Note 6: Calculation of the Total Indicative Dose (TID)

The TID is the committed effective dose for one year of intake resulting from all the radionuclides whose presence in a water supply has been detected, both of natural and artificial origin but excluding tritium, potassium-40, radon and radon decay products. The TID is calculated from the radionuclide concentrations and the dose coefficients for adults laid down in Annex III, Table A of European Directive 96/29/Euratom (laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation). Where the following formula is satisfied, water companies may assume that the TID is less than the parametric indicator value of 0.1 mSv/year and no further investigation is required:

$$\sum_{i=1}^{n} \frac{Ci\ (obs)}{Ci\ (ref)} \leq 1$$

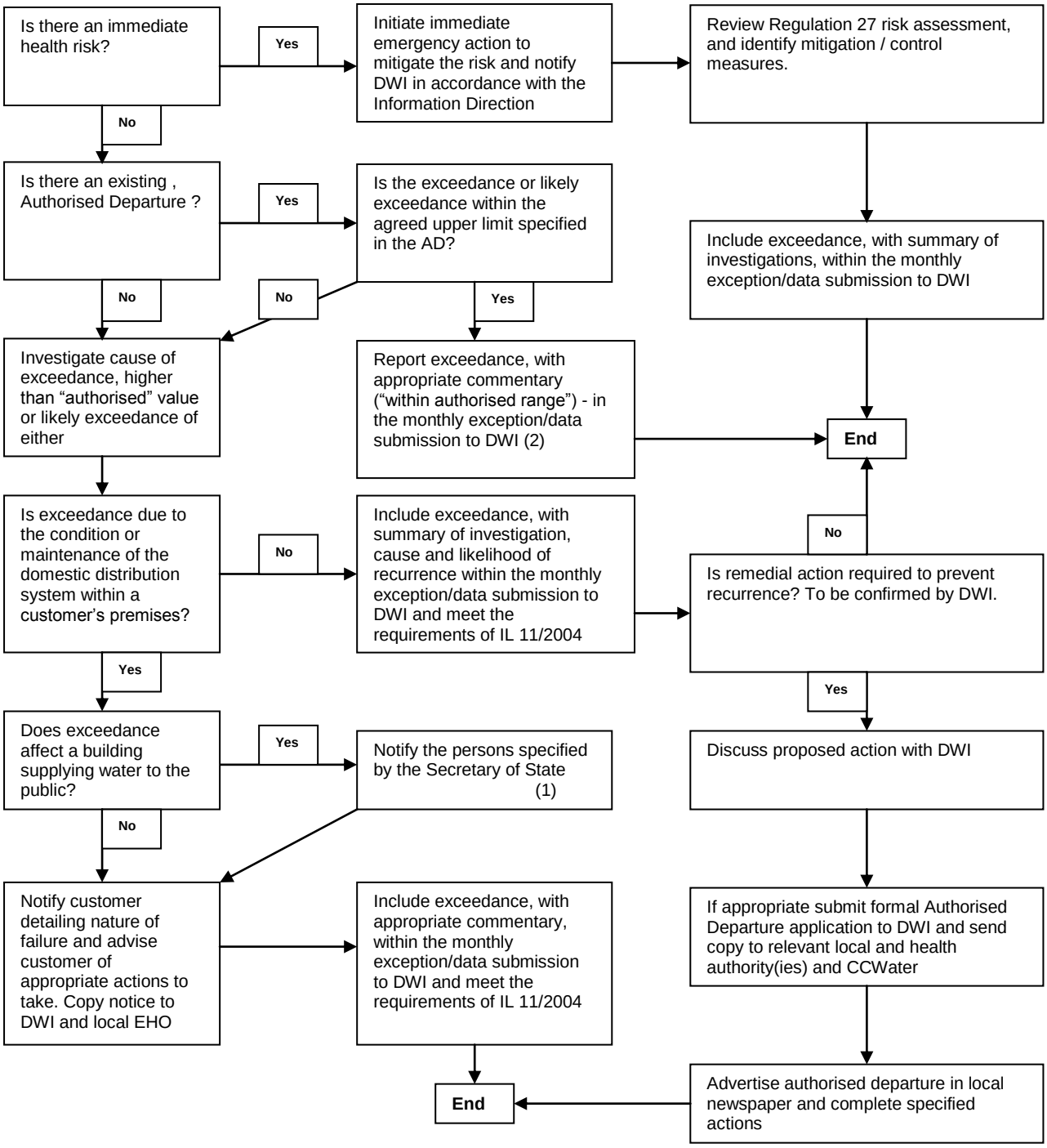
where $C_i(obs)$ = observed concentration of radionuclide *i* $C_i(ref)$ = reference activity concentration of radionuclide *i* (Table 1) *n* = number of radionuclides detected.

Table 1 Radionuclides and Reference Concentrations for drinking water

Radionuclide		Half-life	Reference concentration[a,b], Bq l^{-1}	20% of reference conc
^{14}C	**Carbon-14**	**5730 y**	**240**	**48**
^{32}P	Phosphorus-32	14.29 d	57	11
^{33}P	Phosphorus-33	25.4 d	571	114
^{35}S	Sulphur-35	87.44 d	1054	211
^{60}Co	**Cobalt-60**	**5.27 y**	**40**	**8**
^{90}Sr	**Strontium-90**	**29.12 y**	**4.9**	**1**
^{95}Zr	Zirconium-95	63.98 d	144	29
^{95}Nb	Niobium-95	35.15 d	236	47
^{99}Tc	Technetium-99	213000 y	214	43
^{99m}Tc	Technetium-99m	6.02 h	6227	1245
^{106}Ru	Ruthenium-106	368.2 d	20	3.91
^{125}Sb	Antimony-125	2.77 y	125	24.91
^{125}I	Iodine-125	60.14 d	9	1.83
^{129}I	Iodine-129	1.57 10^{7}y	1	0.25
^{131}I	**Iodine-131**	**8.04 d**	**6.2**	**1.2**
^{134}Cs	**Caesium-134**	**2.062 y**	**7.2**	**1.4**
^{137}Cs	**Caesium-137**	**30 y**	**11**	**2.1**
^{144}Ce	Cerium-144	284.3 d	26.34	5.27
^{210}Pb	Lead-210	22.3 y	0.20	0.04
^{210}Bi	Bismuth-210	5.012 d	105.37	21.07
^{210}Po	Polonium-210	138.38 d	0.11	0.02
^{226}Ra	**Radium-226**	**1600 y**	**0.5**	**0.10**
^{228}Ra	**Radium-228**	**5.75 y**	**0.2**	**0.04**
^{234}U	**Uranium-234**	**244500 y**	**2.8**	**0.6**
^{238}U	**Uranium-238**	**4.468 10^{9} y**	**3.0**	**0.6**
^{228}Th	Thorium-228	1.913 y	0.60	0.12
^{230}Th	Thorium-230	7.7 10^{4} y	2.80	0.56
^{232}Th	Thorium-232	1.405 10^{10} y	3.04	0.61
^{239}Pu/^{240}Pu	**Plutonium-239 / 240**	**2.41 10^{4} y / 6537 y**	**0.6**	**0.1**
^{241}Am	**Americium-241**	**432.2 y**	**0.7**	**0.1**

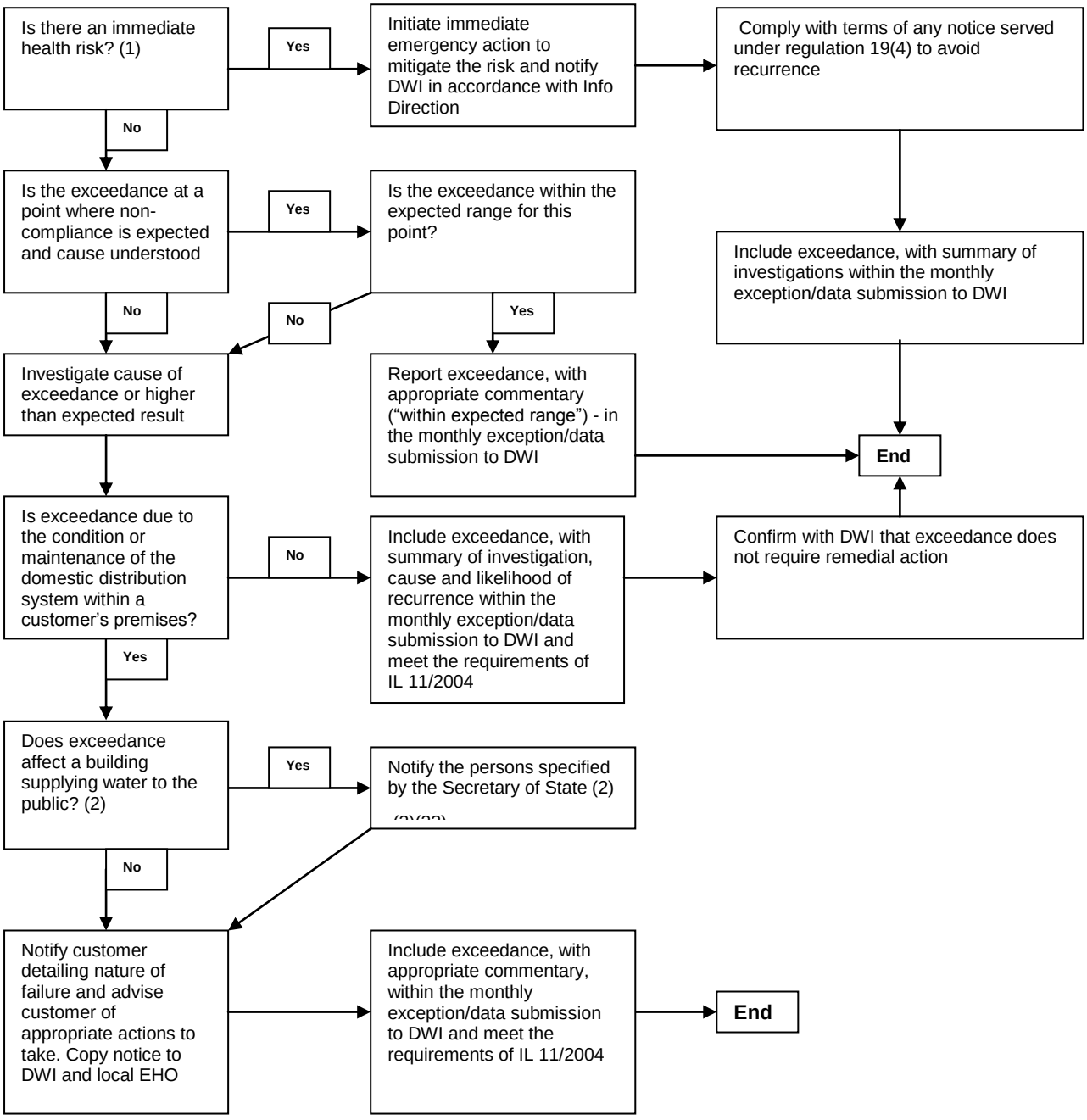
a) Reference concentration corresponds to a dose of 0.1 mSv to an adult (based on an ingestion rate of 730 l y^{-1}).
b) Values in **bold** are for radionuclides included in the EC drinking water directive draft; data for reference concentrations are taken from that document.

APPENDIX 3: PROCEDURE TO BE FOLLOWED IF MANDATORY PARAMETER FAILS OR IS LIKELY TO FAIL A PRESCRIBED CONCENTRATION OR VALUE



Note 1 See Information letter 10/2004.

APPENDIX 4: PROCEDURE TO BE FOLLOWED IF AN INDICATOR PARAMETER DOES NOT MEET A SPECIFICATION



Note 1 An immediate health risk for an indicator parameter is very unlikely but possible (e.g. very high levels of radioactivity)

Note 2 see Information letter 10/2004

APPENDIX 5: LEAD PIPE REPLACEMENT- SUMMARY OF PILOT TRIALS

Strategic lead pipe replacement is defined as a replacement of all lead pipes in a zone or part of a zone (a hot spot of say older properties). Generally there is only a significant public health benefit in mounting such an exercise when both the company and the owners of premises replace their lead pipes (supply and internal plumbing) at the same time in respect of all properties in the hot spot. This is because on average about 75 – 80% of the lengths of lead pipe supplying a property are owned by the premises owner and therefore there is little benefit, on average, in replacing just the company's section of the lead communication pipe. Pilot trials in a number of company areas have led to the following conclusions;

i. generally there is no significant reduction in lead concentrations by just replacing the company's lead communication pipe
ii. generally there is a significant reduction in lead concentration when the premises owners' lead pipes are replaced at the same time as the company's lead communication pipe
iii. when property owners are offered free replacement of their lead supply pipes there is a high take up in rural areas but a low take up in urban areas
iv. generally in urban areas there is very little interest from property owners or occupiers in replacing their lead supply pipes or internal lead plumbing at their own expense when the water company notifies its intention to replace its lead communication pipe.

- In view of the above conclusions it is strongly recommended that the company consults locally, particularly with the local authority and any housing associations and the owners of private premises about whether to mount a strategic lead pipe replacement exercise. The company should decide with the local authority if there is sufficient benefit in public health terms to warrant a strategic lead pipe replacement in exercise in a zone or a hot spot. The circumstances when such an exercise may be warranted are as follows: replacement of all the company's communication pipes (but not the owners pipes) when the average length exceeds the average length of the owners lead supply pipe and internal lead pipes.
- replacement of all the company's lead communication pipes when a significant number of property owners are willing to replace their own lead supply pipes and their internal lead plumbing.
- replacement of all the company's lead communication pipes when a significant number of property owners are willing to replace their own lead supply pipes (but not their internal lead plumbing). This may be justified because the length of lead pipe from the wall to the kitchen tap may be relatively short and in many cases internal lead pipes may have been replaced when kitchens have been refurbished.
- in all cases there must be a joint decision by the company and the local authority about what is a significant number in relation to local circumstances.

APPENDIX 6: SUMMARY OF MONITORING REQUIREMENTS

SUMMARY OF MONITORING REQUIREMENTS											
Parameter	**Unit**	**PCV (Specification for indicator parameters)**	**Point of monitoring**	**Check (high) monitoring**	**Audit (low) monitoring**	**Annual sampling frequency Water supply zones**			**Annual sampling frequency Water treatment works or supply points**		
						Population	**Reduced frequency range**	**Standard frequency range**	**Volume m^3/d**	**Reduced frequency range**	**Standard frequency range**
Table A Microbiological parameters – Directive requirements											
Enterococci	No/100 ml	0	T	X	Yes	Pop B	X	1-8	X	X	X
Escherichia coli	No/100 ml	0	T	Yes	X	<100	X	4	X	X	X
						>100	X	12 per each 5000	X	X	X
Table A Microbiological parameters – National requirements											
Coliform bacteria	No/100 ml	0	T + SR + WTW	Yes	X	<100	X	4	Vol C	12-104[(1)]	4-365
						>100	X	12 per each 5000			
Escherichia coli	No/100 ml	0	SR + WTW	Yes	X	X	X	X	Vol C	12 - 104[(1)]	4 - 365
Residual disinfectant	mg/l	X	T + SR + WTW + SP	X	Yes	<100	X	4	Vol C	12 - 104[(1)]	4 - 365
						>100	X	12 per each 5000			

Table B Chemical parameters – Directive requirements

Parameter	Unit	PCV (Specification for indicator parameters)	Point of monitoring	Check (high) monitoring	Audit (low) monitoring	Annual sampling frequency Water supply zones			Annual sampling frequency Water treatment works or supply points		
						Population	Reduced frequency range	Standard frequency range	Volume m^3/d	Reduced frequency range	Standard frequency range
Acrylamide	µg/l	0.1	PS	X	X	X	X	X	X	X	X
Antimony	µg Sb/l	5	T (or SP) [2]	X	Yes	Pop B	X	1-8	Vol E[2]	X	1-48
Arsenic	µg As/l	10	T (or SP) [2]	X	Yes	Pop B	X	1-8	Vol E[2]	X	1-48
Benzene	µg /l	1	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Benzo (a) pyrene	µg /l	0.01	T	X	Yes	Pop B	X	1-8	X	X	X
Boron	mgB/l	1	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Bromate[3] [4]	µg BrO_3/l	10	T or SP	X	Yes[3]	Pop B[3]	X	1-8	Vol E[2] [4]	X	1-48
Cadmium	µg Cd/l	5	T (or SP) [2]	X	Yes	Pop B	X	1-8	Vol E[2]	X	1-48
Chromium	µg Cr/l	50	T	X	Yes	Pop B	X	1-8	X	X	X
Copper	mg Cu/l	2	T	X	Yes	Pop B	X	1-8	X	X	X
Cyanide	µg CN/l	50	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
1,2 Dichloroethane	µg/l	3	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Epichlorohydrin	µg/l	0.1	PS	X	X	X	X	X	X	X	X
Fluoride	mg F/l	1.5	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Lead [5]	µg Pb/l	25	T	X	Yes	Pop B	X	1-8	X	X	X
Lead [6]	µg Pb/l	10	T	X	Yes	Pop B	X	1-8	X	X	X
Mercury	µg Hg/l	1	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Nickel	µg Ni/l	20	T	X	Yes	Pop B	X	1-8	X	X	X

Parameter	Unit	PCV (Specification for indicator parameters)	Point of monitoring	Check (high) monitoring	Audit (low) monitoring	Annual sampling frequency Water supply zones			Annual sampling frequency Water treatment works or supply points		
						Population	Reduced frequency range	Standard frequency range	Volume m^3/d	Reduced frequency range	Standard frequency range
Table B Chemical parameters – Directive requirements (continued)											
Nitrate[7]	mg NO_3/l	50	T (or SP) [2]	Yes[7]	Yes	Check[7] Pop A	1 - 38	2 - 76	X	X	X
						Audit Pop B	X	1 - 8	X	X	X
Nitrite [8]	mg NO_2/l	0.5	T	Yes[8]	Yes	Check Pop A	1 - 38	2 - 76	X	X	X
						Audit Pop B	X	1 - 8	X	X	X
Nitrite [8]	mg NO_2/l	0.1	WTW	Yes[8]	Yes	X	X	X	Check Vol C[8]	12 - 104[1]	4 - 365
									Audit Vol E	X	1 - 48
Aldrin	µg/l	0.03	T or SP	X	Yes	Pop B [12]	X	1-8	Vol E [12]	X	1 - 48
Dieldrin	µg/l	0.03	T or SP	X	Yes	Pop B [12]	X	1-8	Vol E [12]	X	1 - 48
Heptachlor	µg/l	0.03	T or SP	X	Yes	Pop B [12]	X	1-8	Vol E [12]	X	1 - 48
Heptachlor epoxide	µg/l	0.03	T or SP	X	Yes	Pop B [12]	X	1-8	Vol E [12]	X	1 - 48
Other individual pesticides	µg/l	0.1	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1 - 48
Total pesticides	µg/l	0.5	T or SP	X	Yes	Pop B	X	1-8	Vol E]	X	1 - 48
PAH	µg/l	0.1	T	X	Yes	Pop B	X	1-8	X	X	X
Selenium	µg Se/l	10	T (or SP) [2]	X	Yes	Pop B	X	1-8	Vol E [2]	X	1-48
Tetrachloroethene	} µg/l	} 10	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Trichloroethene											
Trihalomethanes	µg/l	100	T (or SP)[2]	x	Yes	Pop B	X	1-8	Vol E[2]	X	1-48
Vinyl chloride	µg/l	0.5	PS	X	X	X	X	X	X	X	X

Parameter	Unit	PCV (Specification for indicator parameters)	Point of monitoring	Check (high) monitoring	Audit (low) monitoring	Annual sampling frequency Water supply zones			Annual sampling frequency Water treatment works or supply points		
						Population	Reduced frequency range	Standard frequency range	Volume m^3/d	Reduced frequency range	Standard frequency range
Table B Chemical parameters – National requirements											
Aluminium[10]	µg Al/l	200	T	Yes[10]	Yes	Check[10] Pop A	1-38	2-76	X	X	X
						Audit Pop B	X	1 - 8	X	X	X
Colour	mg/l Pt/Co	20	T	Yes	X	Pop A	1-38	2-76	X	X	X
Iron[10]	µg Fe/l	200	T	Yes[10]	Yes	Check[10] Pop A	1-38	2-76	X	X	X
						Audit Pop B	X	1 - 8	X	X	X
Manganese[11]	µg Mn/l	50	T	Yes[11]	Yes	Check[11] Pop A	1-38	2-76	X	X	X
						Audit Pop B	X	1 - 8	X	X	X
Odour		No abnormal change and acceptable to consumers	T	Yes	X	Pop A	1-38	2-76	X	X	X
Sodium	mg Na/l	200	T	X	Yes	Pop B	X	1-8	X	X	X
Taste		No abnormal change and acceptable to consumers	T	Yes	X	Pop A	1-38	2-76	X	X	X
Tetrachloromethane	µg/l	3	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1 - 48
Turbidity	NTU	4	T	Yes	X	Pop A	1-38	2-76	X	X	X

Parameter	Unit	Specification for indicator parameters	Point of monitoring	Check (high) monitoring	Audit (low) monitoring	Annual sampling frequency Water supply zones			Annual sampling frequency Water treatment works or supply points		
						Population	Reduced frequency range	Standard frequency range	Volume m^3/d	Reduced frequency range	Standard frequency range
Schedule 2 – Indicator parameters											
Ammonium	mg NH_4/l	0.5	T	Yes	X	Pop A	1-38	2-76	X	X	X
Chloride	mg Cl/l	250	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Clostridium perfringens(9)	No/100 ml	0	T + WTW(9)	Yes(9)	Yes	Check Pop A	1-38	2-76	Check Vol D(9)	2-1095(1)	2-2190
						Audit Pop B	X	1 - 8	Audit Vol E	X	1 - 48
Colony counts	Number / 1 ml 22°C Number / 1 ml 37°C	NAC	T + SR + WTW	Yes	X	Pop A	1-38	2-76	Vol C	12-104(1)	4-365
Conductivity	µS/cm at 20°C	2500	T or SP	Yes	X	Pop A	1-38	2-76	Vol E	X	1-48
Hydrogen ion	pH value	6.5 – 9.5	T	Yes	X	Pop A	1-38	2-76	X	X	X
Sulphate	µg SO_4/l	250	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Total indicative dose(13)	mSv/year	0.1	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Total organic carbon	mg C/l	NAC	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Tritium(13)	Bq/l	100	T or SP	X	Yes	Pop B	X	1-8	Vol E	X	1-48
Turbidity	NTU	1	WTW	X	X	X	X	X	Vol C	12-104(1)	4-365
Others											
Nitrate / nitrite formula	mg/l	$NO_3/50 + NO_2/3 =<1$	T	X	Yes	Calculate from above sample results	X	X	X	X	X

NOTES

X = Not applicable; **NAC** = No abnormal change; **PS** = Product specification; **SP** = Supply point; **SR** = Service reservoir; **T =** Consumers' taps in WSZ; **WTW** = Water treatment works; **WSZ** = Water supply zone

(1) Reduced frequency not available if <20m^3/d water supplied

(2) Supply point monitoring only if authorised by the Secretary of State under regulation 8

(3) Audit monitoring in WSZ is required only where sodium hypochlorite is added after water has left the WTW

(4) Audit monitoring at SP is required only when sodium hypochlorite is not added after water has left the WTW

(5) Prescribed concentration applies from 25 December 2003 until 24 December 2013

(6) Prescribed concentration applies on and after 25 December 2013

(7) Check monitoring in WSZ is required only where chloramination is practised.

(8) Check monitoring is required only when chloramination is practised

(9) Check monitoring is required only in respect of surface waters (see regulation 6(2) and Table 1 in Schedule 3)

(10) Check monitoring is required when used as a flocculant or where the water originates from, or is influenced by, surface water

(11) Check monitoring is required where the water originates from, or is influenced by , surface waters

(12) If required by pesticide monitoring strategy

(13) If required by radioactivity monitoring strategy

SAMPLING FREQUENCIES

Population A (Check) zones	**<100**	**100 – 4999**	**5000 - 9999**	**10,000 – 29,999**	**30,000 – 49,999**	**50,000 - 79,999**	**80,000 – 100,000**
Reduced frequency	1	2	6	12	18	26	38
Standard frequency	2	4	12	24	36	52	76

Population B (Audit) zones	**<100**	**100 - 4999**	**5000 – 100,000**
Reduced frequency	N/A	N/A	N/A
Standard frequency	1	4	8

Volume C (Check) ***WTW (m^3/day)***	**<20**	**20 – 1999**	**2000 – 5999**	**6000 – 11,999**	**>12,000**
Reduced frequency	N/A	12	52	104	104
Standard frequency	4	52	104	208	365

Volume D (Check) Supply points (m^3/day)	**<20**	**20 – 999**	**1000 – 1999**	**2000 – 5999**	**5000 – 9999**	**10,000 – 15,999**	**16,000 – 32,999**	**33,000 – 49,999**	**50,000 – 67,999**	**68,000 – 84,999**
Reduced frequency	N/A	2	6	12	18	26	52	78	104	130
Standard frequency	2	4	12	24	36	52	104	156	208	260

Volume D (Check) Supply points (m^3/day) continued	**85,000 – 101,999**	**102,000-119,999**	**120,000 – 241,999**	**242,000 – 484,999**	**485,000 – 728,999**
Reduced frequency	156	183	365	730	1095
Standard frequency	312	365	730	1460	2190

Volume E (Audit) Supply points (m^3/day)	**<20**	**20 – 999**	**1000 – 49,999**	**50,000 – 89,999**	**90,000 – 299,999**	**300,000 – 649,999**	**>650,000**
Reduced frequency	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Standard frequency	1	4	8	12	24	36	48

Sampling frequency for all service reservoirs - one sample for each week in which the reservoir is in use