Evaluation of Drinking Water Quality with Respect to the Parameters Lead, Copper and Nickel

Recommendation of the Federal Environment Agency after consultation of the Drinking Water Commission of the Federal Ministry of Health and Social Security

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1. Introduction

1.1 Influencing factors

Concentrations of the metals lead, copper and nickel in drinking water samples taken from consumers' taps are determined mainly by the following influencing factors:

- The materials of the water supply installations
- The design of the water supply installations, particularly of the domestic distribution system
- Operating conditions (flow and stagnation times, consumer behaviour)
- Age of the drinking water installation
- Chemical and physical characteristics of drinking water.

Due to the diversity and overlapping of these influences, analysis results from samples taken from the consumer's tap can vary by whole orders of magnitude not only from location to location, but also over time. Therefore, when evaluating the results, local conditions at the sampling point as well as sampling conditions must be taken into account.

1.2 Directive 98/83/EC on the quality of water intended for human consumption (EC Drinking Water Directive)

Directive 98/83/EC on the quality of water intended for human consumption (EC Drinking Water Directive) takes account of the circumstances outlined above by referring the parametric values for lead, copper and nickel – in keeping with their toxicological rationale - to a sample "obtained by an adequate sampling method at the tap and taken so as to be representative of a weekly average value ingested by consumers". In this context, it envisages "sampling and monitoring methods applied in a harmonised fashion" to be drawn up in accordance with Article 7 (4). The Directive also requires Member States to take account of "the occurrence of peak levels that may cause adverse effects on human health" (Annex I Part B Note 3, EC Drinking Water Directive).

The Directive defines the place of compliance with the parametric values to be "the taps, within premises or an establishment, that are normally used for human consumption" (Article 6 (1) (a), EC Drinking Water Directive). In the vast majority of monitoring cases, these will be taps within the domestic distribution system (consumer's tap).

The Directive exempts Member States from responsibility for changes in quality within the domestic distribution system, except where water is supplied to the public. However, they remain responsible for ensuring that appropriate countermeasures are taken where there is a risk that water from the consumer's tap would not comply with the parametric values.

Since the Drinking Water Directive assumes that responsibility is shared between water suppliers, property owners and consumers, it allows appropriate recommendations or instructions to be issued to all parties concerned (Article 6 (3), EC Drinking Water Directive).

1.3 Ordinance on the quality of water intended for human consumption (Trinkwasserverordnung – TrinkwV 2001)

The reference of the parametric values for lead, copper and nickel to a "weekly average value ingested" as laid down in the Drinking Water Directive has been incorporated into the Drinking Water Ordinance (Annex 2 Part II, TrinkwV 2001).

The health office is required to monitor water supply installations within the meaning of Article 3 no. 2 (c) TrinkwV 2001 (domestic distribution system) if they are used to provide water to the public (Article 18 (1) sentence 2 TrinkwV 2001). For this purpose, it has to set up "a monitoring programme on the basis of suitable random samples" (Article 19 (7) TrinkwV 2001).

If the health office becomes aware of complaints over another water supply installation, it can include it in the monitoring (Article 18 (1) sentence 2 TrinkwV 2001). If it is found in such monitoring that they are due to the domestic distribution system, the health office has to inform the consumers affected and advise all parties concerned of possible remedial action and order it, if necessary (Article 20 (3) TrinkwV 2001).

To fulfil these obligations, the health office has to apply suitable sampling methods and evaluate the results while taking into account the sampling conditions.

1.4 Summary of sampling operations to be carried out or ordered by the health office

The EC Drinking Water Directive and the Drinking Water Ordinance of 2001 give rise to the following occasions for the health office to carry out or order sampling with respect to the parameters lead, copper and nickel:

1. compulsory monitoring of lead, copper and nickel concentrations in supply zones,
2. compulsory monitoring of domestic distribution systems from which water intended for the public is provided (Article 18 (1) sentence 1 in conjunction with Article 19 (7) TrinkwV 2001).
3. when it becomes aware of complaints over water supply installations (Article 18 (1) sentence 2 and within the meaning of Article 16 (3) TrinkwV 2001),
4. determination of lead pipes within the distribution network of the water supplier and, in particular, lead in service pipes (Article 6 TrinkwV 2001),
5. monitoring of new installations (Article 17 (1) TrinkwV 2001).

2 Sampling methods recommended for use

The sampling methods (see Annex) are described in the following:

2.1 Random sample (R-sample)

In a building selected according to random criteria in a supply zone, a sample 1 litre in volume is taken from the tap of a consumer at a random time of day without prior flushing. This may be a building from whose domestic distribution system water is provided to the public.

Explanation

The measurement results for lead, copper and nickel obtained from random samples as part of audit monitoring serve to meet the obligations imposed by Article 7 of the EC Drinking Water Directive.

2.2 Sampling after flushing and stagnation (staged stagnation sampling)

At the tap from which water is usually drawn for consumption, water is to be run until it leaves the tap in the quality delivered by the water supplier (e.g., at constant temperature). The sample 1 litre in volume, taken from the running water (sample S-0), is representative of the drinking water quality delivered by the water supplier.

After completion of this flushing, the tap is shut for a period t (stagnation time in hours) of 4 hours, but not less than 2 hours. Care must be taken to ensure that no water is drawn from the tap during this time. Consumption in other parts of the building is not influenced. After this stagnation period, 2 further samples, each 1 litre in volume, are drawn consecutively without any additional prior flushing (samples S-1 and S-2). The concentration in sample S-1 reflects the influence of the domestic distribution system including the tap (important in the case of nickel and lead, for example) whilst S-2 only covers the influence of the other components of the domestic distribution system.

The concentrations of lead, copper and nickel are determined in all three samples.

If the stagnation period is less than 4 hours but not less than 2 hours, the measured concentration is extrapolated to the concentration after four hours by multiplication with a factor of 4/t (measured concentration * 4/t = normalised concentration).

The normalised concentration is compared with the parametric value and used to determine whether the relevant parametric value is being exceeded. If the normalised concentration exceeds the parametric value, a sample shall be taken after a stagnation period of precisely 4 hours and used as assessment basis as regards orders of the health office pursuant to Article 20 (3) TrinkwV 2001.

Explanation

A variable stagnation period of between 2 and 4 hours was chosen for reasons of practicability. Indication of a precise stagnation period of 4 hours, for example, would

considerably reduce flexibility in the organisation of sampling and would compromise the ability of a sampler to take several samples over a day.

The assumption of a linear increase of concentrations with the stagnation time leads to an overestimation of results from shorter stagnation periods as compared to those of samples with a stagnation period of 4 hours. However, in most cases this will not significantly change the assessment. If the calculated 4-hour concentration exceeds the parametric value, however, another sample has to be taken after exactly four hours of stagnation for validation. This refers exclusively to the S-2 sample.

3 Recommendation on the choice of sampling method and the evaluation of the results

The concentration in a sample representative of the weekly average value ingested by a consumer at a given water quality and type of material depends on the residence time of the water in the distribution system. The reference is a stagnation period of 4 hours. If the concentration in the sample after precisely 4 hours of stagnation does not exceed the relevant parametric value, it is unlikely that it will exceed the weekly average value.

If the parametric value is exceeded, it will be necessary for the health office to carry out an on-site inspection in order to evaluate the domestic distribution system and the service pipe and issue orders pursuant to Article 20 (3) TrinkwV 2001, if necessary.

3.1 Investigations to determine lead, copper and nickel concentrations in a supply zone in accordance with Article 7 (4) EC Drinking Water Directive

For these investigations (“audit monitoring”), random sampling according to 2.1 above is recommended.

Evaluation

The results from the random sample are not suitable for determining whether the parametric value, defined as weekly average value, is being exceeded for any individual installation or individual consumer. They are in principle suitable only for indicating whether there is a risk of parametric values being exceeded within a supply zone.

If it is determined that a parametric value is being exceeded, the causes need to be determined with an investigation according to 2.2 above.

For guidance on the evaluation of the results from staged stagnation sampling, see section 3.3.

3.2 Compulsory monitoring of domestic distribution systems from which water intended for the public is provided

For periodic monitoring of a domestic distribution system from which water intended for the public is provided, random sampling according to 2.1 or staged stagnation sampling according to 2.2 is recommended. The decision as to the type of sampling

is dependent upon the use of the building and the affected consumer groups. It is stipulated in the framework of the specific monitoring programmes of the Federal States.

Evaluation

See 3.1 and 3.3.

3.3 Monitoring in the case of suspected or established non-compliance with a parametric value for lead, copper or nickel

For determining causes, ordering measures, and informing and advising consumers, staged stagnation sampling according to 2.2 is recommended.

Evaluation examples

1. If the normalised concentrations (see section 2.2) of the three parameters specified do not exceed the relevant parametric values in either of the samples S-1 and S-2, no further action is required.

2. If non-compliance with the relevant parametric value is found in the first sample after stagnation (S-1), but not in the second sample after stagnation (S-2) and not in the reference sample after flushing (S-0), the consumer should be advised to allow the first litre to run off before drawing the water for consumption or personal hygiene (the latter holds for the parameter nickel). Attention is drawn to the special situation in the case of an existing nickel allergy. Additional remedial measures are not necessary.

This situation can be expected to occur relatively often in the case of the parameters lead and nickel. But also valves and domestic water meters made of copper alloys can easily lead to elevated lead concentrations.

Non-compliance with the parametric value for nickel is particularly likely in cases where nickel-plated components have been installed or where chrome-plated end fittings are present in which some of the surfaces coming in contact with water have nickel layers not covered by a chrome layer.

3. If non-compliance with the relevant parametric value is found in the second sample after stagnation (S-2), a differentiated evaluation is required. The design of the distribution system (configuration and types of material) has to be taken into account in this evaluation. Technical remedial measures might need to be taken, e.g. additional installation of a supply pipe of a size appropriate to the consumption, or the exchange of nickel-containing fittings. The cause may also come under the responsibility of the water supplier, e.g. a lead service pipe. In the case of non-compliance with the parametric value for lead, it is recommended that the causes be determined according to section 3.4.

Whether compliance with a parametric value is possible simply through a change in consumer behaviour (prior flushing) has to be determined on a case-by-case basis.

If the normalised concentration in the second sample after stagnation (S-2) exceeds twice the relevant parametric value, the consumer will not be able to ensure the maintenance of drinking water quality with sufficient certainty through behaviour change alone. In such cases, the performance of additional technical measures should be considered.

4. If non-compliance with the parametric value is found in the sample drawn after flushing (S-0), the cause might come under the responsibility of the water supplier, e.g. a lead service pipe. In the case of lead, it is recommended that the cause be determined according to section 3.4.

3.4 Determination of lead pipes in the water supplier's network, particularly lead service pipes

To determine lead pipes in the water supplier's network, it is recommended that staged stagnation sampling according to 2.2 be carried out at the water meter.

Evaluation

In evaluating the results, consideration must be given to the fact that additional influences on water quality are likely to result from the domestic distribution system downstream from the service pipe. The Federal Environment Agency's recommendation "Zur Problematik der Bleileitungen in der Trinkwasserversorgung" (The problem of lead pipes in water supply) (Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 46 (2003) 9:825-826) should be consulted.

3.5 Monitoring of new installations

If it can be demonstrated that the requirements of DIN 50930 Part 6 and DIN 50931 have been met in the establishment of new installations, monitoring compliance with the parametric values for lead, copper and nickel is not, in principle, regarded as necessary.

Evaluation

New installations must be subject to stricter standards than existing installations, because Article 10 of the EC Drinking Water Directive requires Member States to take all measures necessary to ensure that materials for new installations used in the distribution of drinking water or the associated impurities in drinking water do not reduce the protection of human health provided for in the Directive. The Drinking Water Ordinance of 2001 takes this into account by requiring, in Article 17 (1), compliance with the generally acknowledged technical standards.

For new installations, it is necessary to require that determined concentrations of the parameters lead, copper and nickel not exceed the respective parametric values in any of the samples; this applies to all cases, including after a residence time of the water in the distribution system of 4 hours. The limits for use laid down in DIN 50930 Part 6 were fixed on this basis.

Annex

Sampling procedures

Taking of a random sample (R-sample)

In a building selected according to random criteria in a supply zone, a sample 1 litre in volume is taken from the tap of a consumer at a random time of day without prior flushing. This may be a building from whose domestic distribution system water is provided to the public.

Sampling after flushing and stagnation (staged stagnation sampling)

At the tap from which water is usually drawn for consumption, water is to be run until leaves the tap in the quality delivered by the water supplier (e.g., at constant temperature). The sample 1 litre in volume, taken from the running water (sample S-0), is representative of the drinking water quality delivered by the water supplier.

After completion of this flushing, the tap is shut for a period t (stagnation time in hours) of 4 hours, but not less than 2 hours. Care must be taken to ensure that no water is drawn from the tap during this time. Consumption in other parts of the building is not influenced. After this stagnation period, 2 further samples, each 1 litre in volume, are drawn consecutively without any additional prior flushing (samples S-1 and S-2). The concentration in sample S-1 reflects the influence of the domestic distribution system including the tap (important in the case of nickel and lead, for example) whilst S-2 only covers the influence of the other components of the domestic distribution system.