United Utilities

Water & Health

Issue 34 - December 2003

Water Safety – Risk management strategies for drinking water

The World Health Organization (WHO) is currently revising their Guidelines for Drinking Water Quality. The Guidelines provide an assessment of the health risks associated with microorganisms, chemicals and radionuclides in drinking water. Shortly after publication of the second edition in 1993, it was decided that they would be subject to a process of rolling revision involving the preparation of reference documents and supporting information. Since 2000, WHO have been working to develop the third edition of the Guidelines through the production of texts describing good practice and the underpinning principles of the guidelines. It is clear that the new Guidelines will advocate a move away from "end of pipe" analysis to a more proactive means of assuring water safety based on a system of quality management, including Hazard Analysis Critical Control Point (HACCP) principles.

This approach was introduced to an international audience at a conference organised by the German Federal Environment Agency, a WHO Collaborating Centre for Research on Drinking-Water Hygiene, in Berlin 28 – 30 April. Following the welcoming address, Dr Jamie Bartram (Coordiantor, Sanitation & Health Programme, WHO) reviewed the Guidelines and their overarching principles with respect to microbiological and chemical constituents. Achieving microbial quality is based on a multiple barrier approach involving source protection, treatment commensurate with raw water quality, and the use of faecal indicators and sanitary inspection. Guideline values for chemicals are based on the no/lowest observed adverse effect level (NOAEL/LOAEL) or a 10^{-5} lifetime excess risk for substances having a threshold or non-threshold response respectively. Dr Bartram described the approach adopted in developing the new Guidelines which is more transparent than previously. The unifying theme is a management approach that provides a framework for water safety (Box 1).

The elements of the framework are

1) Health based targets,
2) Water Safety Plans and
3) Independent surveillance (Box 2).

Water Safety Plans

Water Safety Plans (WSP) are intended to cover all activities under the control of the

Important information regarding the availability of Water & Health

Please note that this will be the last issue of Water & Health that will be available in hard copy. In future Water & Health will only be available for downloading from http://www.unitedutilities.com/. If you would like to be notified when a new issue is available please send an email to: Alan.Godfree@uuplc.co.uk

In this issue:

Water safety 1
The forthcoming third edition of the WHO Guidelines for drinking-water quality will propose a more proactive means of assuring the safety of water supplies

Acrylamide in drinking water 4
The subject of recent publicity – the facts behind the story

Water supply regulations 5
The Water Supply (Water Quality) Regulations 2000 come fully into force at the end of this year. Here we look at the implications for local and health authorities

Jug filters 6
A study by the Drinking Water Inspectorate into the effects of jug filters on drinking water quality came up with some unexpected results

Recently published 7
A review of articles published recently in the field of water and health

For your diary 8
Upcoming meetings

Communications 8
How to get hold of us and details of *Water & Health* on line.

Why do we need a framework for water safety?

- outbreaks of waterborne disease still occur, even in developed countries
- the results of end product testing are not available in time to prevent the supply of unsafe water
- systematises long-established principles
- builds on recent scientific and management developments
- an holistic approach – catchment to consumer.

Box 1

water supplier from source, through treatment, storage and distribution to the consumer. They are consistent with quality management procedures such as ISO 9001 or HACCP but have important additional components, such as communication plans which reflect the multi-agency nature of their development and execution.

The delegates heard presentations by water supply practitioners and health agencies from a wide range of developed and developing countries who described the approaches taken in their region to provide safe drinking water. A number of European water suppliers have adopted quality procedures based on ISO 9001 or 14001 whilst others have introduced systems based on HACCP.

Elements of a water safety framework

Health based targets

- developed by national health agencies
- provide a quantitative public health benchmark
- variable for different solutions

Water Safety Plans

- system assessment i.e. can the system deliver safe water
- identify hazards & threats
- define steps that reduce contamination operational monitoring, ideally in real time
- at each step identified
- different approach e.g. visual inspection
- frequency related to risk
- management plans appropriate for all conditions

Independent surveillance

- determine whether the WSP is operating properly
- a different approach based on
- third party audit
- direct investigation

Box 2

It is probably fair to say that the Australian water industry working very closely with health agencies and other stakeholders have pioneered the development of Water Safety Plans. In separate presentations Melitta Stevens, Kevin Hellier (Melbourne Water), and Daniel Deere (Sydney Catchment Authority) described how the respective water suppliers had adopted quality management systems based on HACCP principles. Key points arising included:

- HACCP plans require documentation of the intended use of the product (i.e. drinking water) because of which there is explicit recognition that tap water is not suitable for all users (e.g. immunocompromised).
- HACCP facilitates the systematic assessment and prioritisation of risk
- risk reduction is achieved incrementally (multiple barriers)
- most control measures (corresponding to Critical Control Points) are not engineered barriers
- Verification activities:
  - may include end point testing (at relatively low frequency as a check)
  - documenting long term water quality (data bases)
  - must be relevant
  - cannot be used to manage risk

Currently five Australian water utilities are externally accredited for HACCP compliance. However Dr Stevens emphasised that independent audit serves only to confirm (or otherwise) that the documented HACCP plan is being followed – it does not confirm that the control measures are appropriate. This can only be achieved by the water supplier validating that control measures are in place and operating effectively.

Small Water Systems

Clearly large water supply operators will have the necessary resources and expertise to develop Water Safety Plans. Their application in small systems and developing countries was a particular theme of the conference. For example, Guy Howard (WEDEC, University of Loughborough) described the development of Water Safety Plans covering urban utility water supplies in Uganda. His experience clearly demonstrated that it is possible to institute a WSP in a country where large numbers of the population rely on communal taps, protected springs or boreholes as their source of water. Dr Theechat Boonyakarnkul from the Thai Ministry of Health gave a fascinating account of the Thailand Safe Tap Water Certification Programme, a unique health intervention initiative. Although the majority of Thailand's 61 million population have access to piped water supplies, many consumers had grown distrustful in the quality of mains drinking water, influenced by perceptions of taste and odour. Expensive bottled water, costing up to 1000 times more than piped supplies, had become the main source of drinking water for the majority of people. Launched in 1998, the Safe Tap Water Certification Programme had as its twin objectives improving the quality of mains water supplies and a communications strategy designed to get across the message that tap water was both safe and affordable. The success of the programme is clear with the proportion of people using mains water increasing from as little as 12% to 78%.

The challenge posed by small systems was illustrated by the case study of an isolated township in Australia's Northern Territory and presented by Roslyn Vulcano. The supply serving 10,000 is a mixture of surface and ground water sources. A desktop exercise showed that improvements in documentation and communications were desirable. The most pressing need was clarification of the responsibilities of other agencies and improvement in inter-agency working. Support for operators of small systems in New Zealand was the subject of the presentation by Chris Nokes

(Environmental Science and Research). The country is dominated by small supplies with over 80% of systems serving less than 500 people, many lacking the resources (expertise, finance for external consultants etc) to develop their own quality management systems. The response was to produce guidance at a national level as a resource for suppliers. Based on HACCP principles, the framework is centred on the concept of a "Hazardous Event" which identifies, for a range of generic water sources, treatment processes and reticulation systems:

- what can go wrong
- why might it go wrong
- what would be the effect
- preventive measures (effectively CCPs).

Documents describing the preparation of risk management plans and individual unit processes have been produced and are available on the web site of the New Zealand Ministry of Health (www.moh.govt.nz/water).

Risk Assessment

Quantitative Microbiological Risk Assessment (QMRA) has been used to establish treatment goals for pathogens that may be present in treated drinking water, most notably Cryptosporidium. It is a tool to quantify health risks, evaluate risk management scenarios and to prioritise risk. Gertjan Medema (KIWA) outlined the various steps necessary to conduct a QMRA (Problem formulation; Hazard identification; Exposure assessment; Effect assessment; Risk characterisation) and how these could be integrated into the preparation of water safety plans. In particular, QMRA can be used to set health-based (water quality) targets and determine whether a particular treatment plant or process train is capable of producing safe water (Box 2).

Risks from Chemicals

Unless present in very large amounts, chemicals in drinking water tend to give rise to long term, chronic health effects unlike microbes which cause acute illness. Other differences exist in the way in which guideline is set, the complexity of analysis, and feasibility of source control or removal (through treatment). John Fawell and Han Heijnen described how HACCP and risk management principles could be applied to chemical hazards in the developed and developing world respectively. Similarities (with microbial hazards) include the analysis of hazard, identification of control points and formulating control measures. Unlike microbes however, there are "safe" levels for chemicals (i.e. the WHO Guideline Value) in drinking water and the ‘risk’ is that of exceeding the guideline value. There are many compounds that may be present in drinking water and guideline values have been derived for over one hundred. The reality is that very few are of real health concern and only then after prolonged exposure. In circumstances where resources are scarce, it is essential to focus on priority chemicals. Dr Heijnen described a protocol for use by developing countries to i) determine priority chemicals; ii) develop risk management strategies; iii) set standards, and iv) define monitoring strategies. In the highest priority are arsenic, fluoride, selenium and nitrate. Arsenic and fluoride are the substances responsible for the greatest burden of disease globally. In Asia, over 100 million people are exposed to arsenic levels in drinking water above 50 µg/l. In China alone, 30 million suffer from skeletal fluorosis with a further 66 million at risk in India.

Health Agencies

The consequences of not implementing and operating a quality management system were illustrated by Steve Hrudey (Univ. Alberta) who highlighted the system failures that contributed to the serious outbreaks of waterborne disease that affected the Canadian towns of Walkerton (May 2000) and Battleford (April 2001). The report of the inquiry that investigated the Walkerton outbreak, recommended a Total Quality Management system (TQM) to include proactive (rather than reactive) strategies to identify and manage risks to public health. David Cunliffe (Dept. Health Services, S Australia) described development of the (Australian) Framework for Drinking Water Quality Management from the perspective of public health services. The Framework was developed jointly by the health and water agencies, with significant involvement from a range of other stakeholders. Writing from a water utility perspective, it was interesting to understand the health agencies’ requirements for a water safety plan. It should come as no surprise that there is a large measure of overlap with those of the water supplier. A benefit of close co-operation that we in United Utilities have identified is the improved understanding (by health and local authorities) of the operational aspects of drinking water supply, which in turn leads to improved decision-making during incidents and emergencies. David similarly identified this aspect as a major gain to health agencies resulting from this partnership approach.

Legislation

It is clear that the third edition of the WHO drinking water guidelines will embrace risk management and a shift towards proactive quality systems within the context of Water Safety Plans. How will this translate into legislation? Pierre Hecq of the European Commission (DG ENV B1) outlined the history of the Drinking Water Directive and offered some areas the Commission may consider in a subsequent revision of the Directive. There may be a need for additional parameters (e.g. algal toxins, endocrine disrupting substances, pathogenic protozoa). Pierre Hecq made it clear that a revised drinking water directive would follow the lead set by WHO in moving to a Water Safety Plan approach. Finally, Bob Breach (Severn Trent Water, UK) posed the question of consumer demands of their drinking water supply. The goal of a water supplier must be to provide good, safe drinking water that has the trust of consumers. The public’s trust in drinking water quality may be eroded by unbalanced media reporting of issues such as endocrine disrupting substances. The taste, odour and appearance of drinking water can affect adversely consumers’ faith in tap water. Although that can be reversed as initiatives in Thailand have clearly shown.

Acrylamide and drinking water

In April 2002, Swedish scientists at the University of Stockholm and Swedish National Food Administration (SNFA) published a report showing high levels of acrylamide had been found in certain foods (Table 1). The studies were confirmed by surveys in UK, Norway, Switzerland and USA. In many of the by-lines used by the media it was stated that acrylamide is used in the treatment of drinking water. This is not the case. It is the polymerised form of acrylamide which is used – Polyacrylamide. This has different chemical characteristics and is non-toxic when compared with the monomer.

Acrylamide (C_3H_5NO) is a man made organic that is derived from benzene (Figure 1). The majority of acrylamide produced is used as a chemical intermediate, for example in organic chemicals and dyes, or as a monomer in the production of polyacrylamide. Acrylamide is also present in cosmetics and soap preparations and to some extent as binders in adhesives and adhesive tape. Acrylamide is present in cigarette smoke.

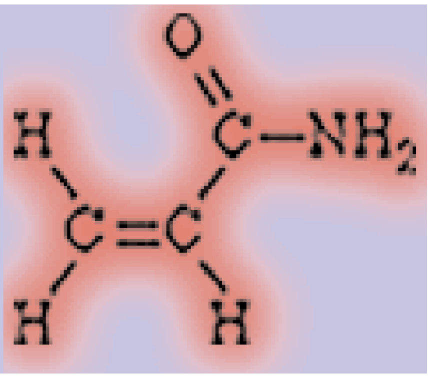

Figure 1

Polyacrylamides are used as:

- coagulant/filter aids in drinking water and sewage treatment processes
- binding agents for pulp and paper industries
- soil stabilisers
- grouting agents in the construction of service reservoirs and wells.

Acrylamide and food

In the Study carried out by the University of Stockholm the acrylamide levels in food were found to be 500 times greater than the WHO drinking water quality guideline value.

Table 1 shows the concentrations of acrylamide found in certain types of food, for example potato chips, french fries, bread and processed cereals following baking, frying or grilling (Swedish National Food Administration 2002). Current research suggests that acrylamide is formed due to a reaction between the amino acid asparagine and sugars (Maillard reaction) during the heating to high temperatures (>120°C) of starch based foods (Mottram *et al*. 2002). No acrylamide has been found in boiled foodstuffs. The Maillard reaction is also thought to be responsible for the production of the flavour and food colour generated during baking and roasting. However, the actual mechanism has not been established and further research is required. It was also noted that if french fries were over cooked the concentrations of acrylamide were significantly higher.

The WHO concluded from data available in June 2002, that food makes a significant contribution to total exposure to acrylamide with the population receiving an average daily acrylamide intake between 0.3 and 0.8 µg per kg body weight.

Health effects

The major exposure routes to acrylamide for the general population are via food and tobacco smoke. The average intake levels of acrylamide from all sources is approximately 70 µg per day for an adult. This is significantly below that which is known to cause nerve damage in laboratory animals. The prescribed concentration or value for drinking water in the UK is 0.1 µg/l. The average person consumes 2 litres of water a day. The WHO guideline value of 0.5 µg/l for drinking water was determined using an excess lifetime cancer risk of 10^{-5}.

The International Agency on Cancer Research (IARC) (1994) identified acrylamide as a probable human carcinogen (Group 2A) based on experimental data in animals. It is the acrylamide metabolite glycidamide which was shown to be genotoxic in rats.

The main symptoms of acrylamide poisoning are damage to the nervous system, weakness, lack of co-ordination in legs, paralysis and cancer. However, a paper published in the British Journal of Cancer (Mottram *et al*. 2002) reported that the incidence of bowel, bladder and kidney cancer was not associated with the consumption of high levels of acrylamide in the diet.

Occupational exposure studies to acrylamide have involved workers in factories manufacturing acrylamide based flocculants. Typical symptoms included skin irritation, generalised fatigue, foot weakness and sensory changes.

A family of five suffered from acrylamide poisoning after drinking water containing 400 mg/l acrylamide as the result of a grouting operation in their local well. The toxicity symptoms appeared a month later as confusion disorientation, memory disturbances and hallucinations. The family recovered fully within four months.

Polyacrylamide and water treatment

Polyacrylamide is used as a filter aid in drinking water treatment processes. The monomer acrylamide can be found in extremely low concentrations (generally less than 0.05%) within polyacrylamide formulations (based on active polymer content).

The practical quantification level for acrylamide in drinking water is 1 µg/litre. Acrylamide is, therefore, regulated by product and dose specification rather than by determination of concentrations in drinking water. In the UK the Committee on Chemicals and Construction Materials (CCM) specify that polyacrylamide coagulants must not contain more than 0.025% of the free acrylamide monomer (0.020% from December 2003). In addition the average polyacrylamide dose should be lower than 0.25 mg/l and never exceed 0.5 mg/l of the active polymer (BS EN 1047:1998 Anionic and nonionic polyacrylamides and BS:EN 1410:1998 Cationic polyacrylamides). The maximum content of free acrylamide monomer must be stated by the supplier for every batch of polyacrylamide. Water companies must also take into account the acrylamide concentration in any water recycled to the front of the water treatment works if polyacrylamide is used to treat the sludge.

Table 1: Acrylamide concentration for several food groups: Swedish National Food Administration, 2002

Food group	Acrylamide concentration ($\mu g\ kg^{-1}$) Median	Min-max	Number of samples
Potato crisps	1200	330-2300	14
French fries	450	300-1100	9
Pan-fried potatoes	300		1
Biscuits and crackers	410	<30-650	14
Crispbreads	140	<30-1900	21
Breakfast cereals	160	<30-1400	15
Corn chips	150	120-180	3
Soft breads	50	<30-160	20
Various fried foods (pizza, pancakes, waffles, fish fingers, meatballs, chicken bits, deep fried fish, vegetarian schnitzel and cauliflower gratin)	40	<30-60	9

The ability of the polyacrylamide to act as a filter aid means that much is encompassed in flocs which are held by the filter and subsequently removed by backwashing. Acrylamide is also readily adsorbed by GAC which is widely used as a filter media in the North West. In studies GAC removed 94 to 96% of acrylamide from a sample containing 0.5 mg/l and 68 to 70% from a sample containing 10 mg/l.

In the North West polyacrylamide is currently used as a coagulation aid at 22 water treatment works and at another 13 sites for sludge thickening (February 2002).

To put the drinking water values into context, you would need to drink over 40 litres of water containing the 0.1 µg/l standard to receive the same acrylamide dose that is in one average packet of crisps (average concentration taken from Swedish National Food Administration data, 2002).

Summary

High acrylamide concentrations in food are a recent discovery, however they are likely to have been present for hundreds of years. The heating of starch based foods to high temperatures is not a modern day development. The WHO have not said that these foods should not be eaten, but recommend that people should have a healthy balanced diet.

Acrylamide is not used in the treatment of drinking water. It is the polymerised form - polyacrylamide that is used as a filter aid. Polyacrylamide has different chemical characteristics to acrylamide and is not considered carcinogenic.

Low concentrations of acrylamide are present in polyacrylamide but the addition of polyacrylamide to water is heavily controlled by both product and dose specification.

To lower intake of acrylamide high carbohydrate foods cooked at high temperatures should be avoided. These concentrations are significantly higher than any that would be received via drinking water.

Sources of information

Mottram, D.S. *et al*. 2002 Food Chemistry: acrylamide is formed in the Maillard reaction. *Nature* **419** 448-449.

Swedish National Food Administration (2002) Information about acrylamide in food. Uppsala, Sweden. April 2002. http://192.71.90.8/engakrylanalysresultat.htm

UKWIR Toxicity Database – Acrylamide factsheet

USEPA Technical factsheet on acrylamide - http://www.epa.gov/safewater/dwh/t-voc/acrylami.html

WHO Guidelines for Drinking Water Quality, Acrylamide - http://www.who.int/water_sanitation_health/GDWQ/Chemicals/Acrylamfull.htm

The Water Supply (Water Quality) Regulations 2000 – Implications for Local and Health Authorities

The Water Supply (Water Quality) Regulations 2000 (and the amending regulations of 2001) implement the 1998 European Directive concerning the quality of drinking water (98/83/EC). Implementation has taken place in stages and the regulations will be fully in force on 1 January 2004. In drafting the current Directive, the Commission sought to introduce greater transparency by ensuring that consumers are provided with more information about the quality of their drinking water than hitherto.

Communications with local and health authorities

The impact (of the 2000 Regulations) on local authorities will be mainly unchanged in terms of reporting requirements. As is currently the case, the 2000 Regulations require water companies to notify local authorities and health authorities of situations where an event gives rise or is likely to give rise to a significant risk to health.

In the intervening period between the regulations being drafted and their implementation, changes in the structure of the health service resulted in the formation of Strategic Health Authorities and the Health Protection Agency (HPA). The Drinking Water Inspectorate (DWI) has issued guidance to water companies on the 2000 Regulations (http://www.dwi.gov.uk/regs/regulations.htm). This addresses the changed health service structure and defines reference to a "health authority" as:

(i) the relevant Consultant(s) in Communicable Disease in the Health Protection Agency ; and

(ii) the Director of Public Health for the relevant Primary Care Trust(s).

The guidance goes on to say that "Water companies may enter into alternative local reporting arrangements with health authorities with the written agreement of the parties identified above. Such arrangements should be reviewed regularly." We are exploring with the HPA and Trusts how this will handled in practice.

The 2000 Regulations introduce a new duty on a water company to apply to and obtain from the DWI, an Authorised Departure from the Regulations if it wishes to supply temporarily water that does not comply fully with the water quality standards set out in the Regulations, until such time as remedial action is completed.

Water companies are required to provide a copy of the application to local authorities, the Health Protection Agency and NHS Primary Care Trusts so that they may, if they wish, make representations to DWI. Any response will be considered by the DWI in arriving at a decision whether to grant an application for an Authorised Departure. When authorised, the water company will publish details (of the Departure) in the form of a notice to be carried in local newspapers.

Investigating breaches of the standards

United Utilities has, for many years, provided local authorities with details of individual samples taken from customers' taps that fail the standards for lead or bacteriological quality. This is done in the form of a monthly report to the Environmental Health department of the relevant local authority, which in addition to summary water quality data, gives details of individual breaches of the standards for lead and coliforms. Local authorities also receive an annual report summarising the results of analysis carried out at treatment works, service reservoirs and within water supply zones.

In furtherance of the Commission's desire for greater transparency, the new Regulations require water suppliers to notify consumers of a failure of a parameter due to the domestic plumbing. The list of parameters likely to give rise to failures is small comprising plumbing metals (lead and copper) and bacteriological (*Escherichia coli*, Enterococci). In addition to informing customers of the results in writing, the water supplier must advise them what steps should be taken (if any) to safeguard their health. A copy of each notification must be sent to the relevant local authority and the DWI.

Summary

The roles and duties of local and health authorities under the 2000 Regulations are not markedly different from that established by the 1989 Regulations. Local and health authorities will be made aware at a much earlier stage of quality issues, especially when authorised departures are applied for. They will also receive notification of specific water quality failures at customers' premises. The working model adopted following the formation of the HPA, based on the three Health Protection Units in the north west, appears to be working well and there is no reason why the changes brought about by the new Regulations cannot be accommodated equally well.

Jug water filters and water quality

Jug water filters are becoming increasingly popular with domestic customers to improve certain aspects of the water supply, for example the removal of chlorinous taste. The DWI commissioned WRc to investigate the effect of filtering drinking water through a portable jug filter under standard and simulated misuse situations.

Jug filters normally comprise granular activated carbon (GAC) and a weak base ion exchange resin impregnated with silver ions. The ion exchange resin serves to replace the calcium and magnesium ions in the water with hydrogen ions, thereby artificially softening the water and reducing the pH. The GAC removes chlorine and some organic material from the water and the silver ions act as a biocide to reduce bacterial accumulation in the filter cartridge.

The DWI study

A nutrient rich surface water and a nutrient poor groundwater were filtered through three types of typical household jug filter. A hard groundwater and a soft water were used in the metals leaching trials. The filtered water was sampled for microbiological and chemical quality and subsequently boiled in kettles with either a nickel plated or concealed element.

General quality of filtered water

The initial investigations showed:

- A significant reduction in pH in filtered water.
- Bacterial levels were slightly higher in the filtered water compared to the feed water, but overall there was no evidence that jug water filters had an adverse effect on microbial water quality.
- If the filter was used beyond the designated lifetime (normally 28 days) there was an increase in bacterial numbers in the filtrate.
- A difference in taste and odour between filtered and unfiltered water, this was due to the removal of chlorine by the filter.
- Bacterial numbers were high in the first litre filtered after a period of non use. (Manufacturers normally recommend that the first two litres of water should be discarded).
- Higher concentrations of silver ions in the filtrate than the feed; the levels declined as the water filter aged. There is limited toxicity data on the presence of silver in drinking water and currently no regulatory standard.
- Elevated levels of nickel in the filtered water after boiling.

Pathogen testing

The filters were spiked with high concentrations of salmonella and *Escherichia coli* to simulate the cross contamination of the filter from general activities in the kitchen. These organisms were only present in the first litre filtered after their introduction. This suggests that the silver ions do act as an effective biocide.

Metal leaching studies

Due to the higher than expected nickel concentrations in boiled water further trials were conducted with a wider range of kettles (8 models) which included those with nickel exposed, stainless steel and concealed elements. The assessments were carried out with a hard groundwater and a soft water collected from WRc-NSF Oakdale.

There was substantial leaching of nickel into both the filtered hard and soft waters when boiled in kettles with exposed nickel-plated elements (Table 1). The feed pH was between 7 and 7.8 and after filtering the hard water varied from pH 4.15 to 5.57 and soft water from pH 3.94 to 6.15. There was little leaching of the other metals that were tested for i.e. chromium and iron. Nickel leaching was enhanced in the presence of calcium, therefore less leaching occurred in soft water than hard water. The majority of public water supplies in the North West region are soft.

High nickel concentrations were also found when unfiltered water samples were boiled in kettles with exposed nickel plated elements but these concentrations were not as high as the boiled filtered water (Table 2). Table 2 also shows how the nickel concentrations fell as the filter became exhausted after 4 weeks use.

These trials were carried out with kettles that were less than a month old, however further studies included representative kettles from customers in which the kettles were greater than two years old. With older kettles there was not a marked increase in nickel concentration although levels did increase after the kettle had been descaled.

European proposals for standardisation of water supply fittings are expected to lead to the withdrawal of nickel coatings in direct contact with tap water. This will not however, cover consumer appliances such as kettles.

Nickel and drinking water

The average intake of nickel per day in the UK is 0.13 mg/day from food, for example from pulses, nuts and oats and 0.02-0.04 mg/day from drinking water (WHO). Nickel is also present in a few multi mineral food supplements at levels of approximately 0.005 mg/daily dose. The prescribed concentration or value (PCV) for nickel in

Table 1: Nickel concentrations (μg/l) in hard and soft water when boiled in kettles with exposed and concealed elements.

	Hard water	Soft water
Filtered and boiled in exposed element	244	51
Filtered and boiled with concealed element	5.23	1.9
Feed water	4.55	0.8

Table 2: Concentrations of nickel (μg/l) in water (both previously filtered and unfiltered) after boiling in kettle with a nickel-plated element after one and four weeks filter use.

	Minimum	Mean	Maximum
	1st week of filter use		
Boiled filtered water (mean of all filters)	59	1799	5380
Boiled unfiltered water	185	723	2470
	4th week of filter use		
Boiled filtered water (mean of all filters)	37	83	358
Boiled unfiltered water	46	64	73

drinking water is currently 50 µg/l but this will be tightened to 20 µg/l from December 2003. All tap samples in these trials met the current UK Water Quality Regulations.

Health effects of Nickel in water

Nickel causes skin sensitisation and a high proportion of the population (7-10%) (particularly women) have become allergic to nickel through extended contact with the skin e.g. costume jewellery. Ingestion of nickel at high concentrations in food or drinking water can potentially cause dermatitis in nickel sensitive individuals. There is some suggestion that ingestion of low doses of nickel may desensitise some individuals who are nickel sensitive. However, the threshold for nickel sensitisation is unclear at the present time. Nickel may also impair iron adsorption or utilisation when iron status is low.

The adsorption of nickel from beverages such as tea and coffee is reduced when compared to water alone, but there is limited data available on the consumption and uses of boiled water. The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment recommended that further research into possible exposure from use of different filters and kettles under normal conditions is required and for the data to be statistically analysed.

Summary

The use of a household jug filter does not, on the whole, result in a deterioration in water quality even under simulated misuse situations. However, elevated levels of nickel were found in water boiled in a kettle with a nickel plated element. The concentrations were generally higher if the water had previously been filtered through a household jug filter. The nickel concentrations declined with filter age and kettle age (apart from a period following descaling) and were generally lower in softer water compared to hard water.

Further studies have been commissioned to provide more information on exposure to nickel with particular reference to different water sources.

The current advice to nickel sensitive individuals is when you wish to replace your kettle it would be advisable to purchase one with a stainless steel or concealed element.

The executive summary can be found at http://www.fwr.org/water/dwi0826.htm and the full report can be purchased through the foundation for water research website at http://www.fwr.org

Recently published

A regular feature listing contemporary published material that you may have missed:

Guidelines for Safe Recreational Water Environments. Volume 1, Coastal and fresh waters

World Health Organization, Geneva. ISBN 92 4 154580 1, 219 pp. This is the first of two volumes of Guidelines for Safe Recreational Water Environments (Volume 2 covers swimming pools, spas and similar environments). The Guidelines are intended to provide regulators with a scientific consensus as a basis for setting national or international standards. They cover a wide range of hazards such as drowning, physical injury, exposure to heat, cold and sunshine, water quality and dangerous aquatic organisms. Several aspects of water quality are considered; faecal contamination, free-living microorganisms (e.g. Vibrios, *Acanthamoeba* spp, *Naegleria fowlerii*), algae and chemical hazards. In line with current thinking, the Guidelines promote a move away from reliance on retrospective compliance assessment to real-time management to protect public health. Guideline values for microbiological water quality are based on the numbers of intestinal enterococci (95th percentile), which can be used in combination with sanitary surveys to derive a classification matrix. The Guideline values for microbial quality (intestinal enterococci/100 ml) are A (<40), B (41-200), C (201-500) and D (>500) which equate to a risk of bathing associated gastrointestinal illness of <1%, 1-5%, 5-10% and >10% respectively.

Outbreaks of infectious disease associated with private drinking water supplies in England and Wales 1970-2000

Said, B., Wright, F., Nichols, G.F., Reacher, M. & Rutter, M. *Epidemiology and Infection* (2003) 130 (3): 469-479 Approximately 300,000 people in England and Wales obtain their drinking water from a private supply. The majority of private supplies (60%) serve a single dwelling. Data reported to the Communicable Disease Surveillance Centre (CDSC) over the 30-year period show that there were 25 outbreaks of infectious disease linked to the use of a private water supply (PWS). The majority (16) were reported during the last decade of the period subsequent to the introduction of enhanced surveillance. The outbreaks affected 1584 people of at least 5190 who were at risk. The most commonly identified pathogen was campylobacter which was present in 13 (52%) of the disease outbreaks. *Escherichia coli* O157 was the only other bacterial pathogen linked with illness. The protozoan parasites giardia and cryptosporidium were linked with four outbreaks (15%) and a further outbreak involved mixed infections of cryptosporidium and campylobacter. A viral aetiology was suspected in one outbreak and no causative agent was identified in a further four. Illness was characterised by gastrointestinal symptoms in 23/25 outbreaks. The remaining two involved an outbreak of paratyphoid fever and an outbreak of streptobacillary fever (*Streptobacillus moniliformis*) at a boarding school with 304 cases amongst the 700 exposed. The authors identified the factors implicated with outbreaks which included the use of surface water (spring/stream), lack or failure of treatment, grazing animals or slurry spreading on adjacent land, poor maintenance of structures and antecedent rainfall.

Foot and Mouth Disease in livestock and reduced cryptosproridiosis in humans, England and Wales

Smerdon, W.J., Nichols, T, Chalmers, R.M., Heine, H. & Reacher, M. *Emerging Infectious Disease* (2003) 9 (1); 22-28 In 2001 the UK experienced a major outbreak of Foot and Mouth Disease (FMD) with over 2000 premises affected in the period mid February to the end of September. Livestock on over 9500 premises were slaughtered because the presence of FMD had been confirmed or they were designated as dangerous contacts (i.e. on adjoining farms). This paper examines the incidence of

continued

Water & Health is produced as an information service to the Environmental Health Officers and Public Health Doctors in the North West. Material in 'Water & Health' is in the public domain and may be used and copied without permission; acknowledgement of source, however, is appreciated. Comments, letters and ideas for future issues are welcomed. Requests for further copies or change of address should be sent to the Public Health Section of United Utilities or by email to: Alan.Godfree@uuplc.co.uk

Recently published *continued*

cryptosporidiosis during the FMD outbreak and investigates the possible relationships between the two diseases. The incidence of cryptosporidiosis is characterised by peaks during the spring and autumn. It is believed that the spring peak can be attributed to environmental contamination whereas the second peak in autumn reflects infections acquired during travel outside the UK. Laboratory reports of human cryptosporidiosis were modelled using regression analysis for the period of the FMD outbreak. This showed an estimated 35% reduction across England and Wales as a whole, but there were significant regional differences. The smallest reduction (10%) occurred in the West Midland and Trent regions; the largest reduction was in the North West (65%). The link with FMD is strengthened by a coincident reduction in the proportion of genotype 2 cryptosporidium isolates (livestock and human strain). The characteristic autumn peak was observed in 2001. The authors suggest two reasons to explain the association between FMD and the reduced incidence of cryptosporidiosis. Firstly, that restrictions on public access to the countryside, instigated as part of the FMD controls, reduced the likelihood of people being exposed to cryptosporidium oocysts in the environment. An alternative hypothesis is that contamination of drinking water was reduced because livestock were removed from catchment areas through culling or being held elsewhere.

Comment:

the paper makes reference to a particular unfiltered water supply in the English Lake District that supplies drinking water to approximately one-third of the north west region. The supply in question is Thirlmere, a source epidemiologically linked with community outbreaks of cryptosporidiosis (see Water & Health 27/99). It is interesting to note that despite the large number of FMD cases in the north west of England, none were located on the Thirlmere catchment. The density of livestock was not markedly different from previous years. Intriguingly the reduction in cryptosporidiosis in the north west during 2001 (427 cases) was sustained in 2002 (531 cases) compared with pre FMD (1238 cases in 2000). There was no spring peak again in 2003.

For your diary

CIWEM/Aqua Enviro 3rd Management of Wastewaters Conference,
19- 21 April 2004, York, UK. Contact Sarah Hickinson Tel. 0113 2424200, email: sarahhickinson@aquaenviro.co.uk

Diffuse Pollution and the Water Framework Directive,
5 May 2004, SOAS, London.
For further information, email: bob.earll@coastms.co.uk

IWA World Water Congress,
19 - 24 September 2004, Marrakech, Morocco. Information and call for papers: www.iwa2004marrakech.com

4th International Giardia Conference and first combined Giardia/Cryptosporidium meeting
20-24 September 2004, Amsterdam, the Netherlands. Website http://www.giardiacrypto2004.org/

Communications

If you have any queries regarding water quality or would like further information please contact Service Enquiries on 08457 462200. You can still use this number out-of-hours when it will divert to our Operations Control Centre which is manned 24 hours a day, 365 days a year.

More specialist enquiries can be directed to the Public Health Section. Our FAX number is 01925 463724 and the office number for telephone enquiries is 01925 234000. Even if we are not in the building, we can usually be contacted quickly by a radiopaging service which operates across the region.

Alternatively you can write to us at:
Public Health Section
United Utilities
Lingley Mere Business Park
Lingley Green Avenue
Great Sankey
WARRINGTON
WA5 3LP

E-mail to: Alan.Godfree@uuplc.co.uk

Water & Health on-line

Starting with issue 20/97, an electronic version of Water & Health has been available on the United Utilities website for download as an Acrobat® pdf file. This site has been redesigned and as a result the location of the Water & Health page has moved. Point your browser to:
http://www.unitedutilities.co.uk/index.asp?section=community_environment&subsection=Water_Health

Don't forget to bookmark the page.
The Acrobat® reader software for viewing and printing the files is freely available on the web. Details of where to obtain a copy are included on our web page or the software can be obtained directly from Adobe at http://www.adobe.com