The Irish Expert Body on Fluorides and Health An Corpán Oilte Éireannach um Fluairídí agus Sláinte

# CODE OF PRACTICE ON THE FLUORIDATION OF DRINKING WATER

# 2016]



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- Directorates
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- Primary Community and Continuing Care
- Assistant National Director Oral Health
- Central Purchasing Unit
- Principal Environmental Health Officers
- Principal Dental Surgeons

Fluoridation Monitoring Committees

	National Steering Committee on Fluoridation
	County and City Managers Association
	Association of Consulting Engineers
	The Society of Chief and Principal Dental Surgeons in Ireland
	The Environmental Health Officers Association
	Health and Safety Authority
	Environmental Protection Agency
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# **1. INTRODUCTION**

This document is a revision of the Code of Practice on the Fluoridation of Drinking Water 2007. Key changes to the Code of Practice include changes regarding responsibility for water fluoridation. Irish Water (previously the local authorities) now acts as an agent of the Health Service Executive in fluoridating water supplies. This Code of Practice [and related Standard Operating Procedures (SOP)] is intended for use by the local authorities (as agents of Irish Water under its Service Level Agreement)

Recommendations regarding monitoring procedures, recording and reporting of results, and the corrective actions in the non-conformance protocol have been tightened. Improvements have also been made to risk management and the Hazard Critical Control Points in the Fluoridation Process (HACCP) including procedures such as delivery and bulk storage of hydrofluosilicic acid, bunding, pump output including accuracy and filling from the bulk tank. The Expert Body has carried out a consultation process with the relevant stakeholders and has incorporated these suggested changes where applicable to ensure continuous improvement of this working document.

Fluoridation of drinking water, commenced in Ireland in 1964 following the introduction of the Health (Fluoridation of Water Supplies) Act 1960. The Act provides that health authorities shall arrange for the fluoridation of public piped water supplies. The Act also provides that the Minister for Health may make regulations requiring sanitary (local) authorities to act as the agents of health authorities in fluoridating public piped water supplies. Currently approximately 70% of the population receives fluoridated water from public water supplies. The functions of local authorities in relation to water supplies are now the responsibility of the public utility, Irish Water. Service Level Agreements (SLAs) and Annual Service Plans (ASPs) have been negotiated by Irish Water with the local authorities.

Dental caries (dental decay) is a common disease which affects the teeth. It commences as a destructive process of the dental enamel, and if left untreated, can affect the dentine (the tooth tissue beneath the dental enamel). Dental caries (dental decay) can be painful, is expensive to treat, and can lead to loss of teeth, and impairment of function, including chewing or speaking as well as adversely affecting appearance.

The initial dental caries (dental decay) process is caused by acid which attacks the dental enamel (demineralisation). This acid is produced following consumption of sugary food and drinks. Fluoride makes teeth more resistant to tooth decay by slowing down the rate of demineralisation following consumption of sugary food and drinks. It also helps to repair the tooth enamel (remineralisation) when the acid attack is over. Fluoride also inhibits the process by which the bacteria produce acids. Fluoride is most effective in the control of decay if a low constant level of fluoride is maintained in saliva. This can be achieved through use of optimally fluoridated drinking water and through daily use of fluoridated toothpaste.

The use of fluoride in different forms in the prevention of dental caries has been widely researched both in Ireland and internationally. Water fluoridation continues to be the most effective public health measure for the prevention of caries. There is currently no evidence that fluoridation of water at recommended levels has any adverse effects on health. An increase in dental fluorosis is the only effect consistently associated with water fluoridated at recommended levels and it has also been associated with use of other fluoride sources such as toothpaste and supplements. Dental fluorosis affects the appearance of the surface of the tooth. At the level of fluoride used for water fluoridation, dental fluorosis typically appears as fine white lines which are difficult to see. In countries with naturally occurring very high levels of fluoride pitting or staining of enamel may occur. The levels of dental fluorosis seen in Ireland are primarily of the very mild forms, are cosmetic in nature, and do not require treatment. The Forum on Fluoridation recommendation to reduce the level of fluoride in drinking water was designed to address the rising prevalence of dental fluorosis noted in successive national surveys. A similar approach was taken in other areas such as Hong Kong and Toronto. It is important to note that fluorosis is one of many reasons for a change in the appearance of the tooth.

EU law defines a maximum permitted concentration of 1.5ppm fluoride for public water supplies through its drinking water directives (The European Drinking Water Directive (DWD), Council Directive 98/83/EC). In Ireland, the permissible range of fluoride in drinking water has been defined in Regulations made under the Health (Fluoridation of Water Supplies) Act 1960, (S.I. No. 42 of 2007) as being not less than 0.6 mg/l (ppm) fluoride and not greater than 0.8 mg/l (ppm) fluoride. Furthermore, the European Communities (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014) set a parametric value (i.e. maximum limit) of 0.8 mg/l (ppm) for fluoridated drinking water for Ireland.

Constant monitoring to ensure that the fluoride concentration in public piped water supplies is maintained within the correct limits is essential. Only water supplies under the control of Irish Water are fluoridated. Some group water schemes may purchase water from a local authority/water services authority source while the distribution network remains under the control of the group scheme. Other group schemes provide their own sources of water. The group water schemes do not come under the scope of the Act.

The Drinking Water Safety Plan (DWSP) approach, as recommended by the World Health Organisation should be implemented. The DWSP should take into account the risks around water fluoridation. Guidance is available on the website of the Environmental Protection Agency (EPA). Drinking Water: Environmental Protection Agency, Ireland

# 2. PURPOSE

The purpose of the Code is to ensure efficient and effective implementation of the technical aspects on the procedures for the fluoridation of drinking water, by all personnel involved and hence to ensure that:

- 1. The fluoride concentration of fluoridated water supplied to the consumer will be within limits set by Irish and European legislation.
- 2. The potential for environmental contamination from hydrofluosilicic acid spillages is minimised
- 3. The risk of injury to fluoridation plant personnel from hydrofluosilicic acid is minimised.

It must be emphasised that this Code of Practice does not purport to be a guide to compliance with Safety Health and Welfare at Work legislation and should not be interpreted as such. Neither is the Code of Practice intended to absolve any individual or organisation from its obligation to comply with more detailed or specific safe work systems, provisions or guidelines relating to Fire Safety; Safety, Health and Welfare at Work or Environmental Protection.

The key objective of this Code of Practice is the achievement of high quality fluoridated water supplies that will enhance the oral health of those members of the public who receive fluoridated drinking water.

# 3. SCOPE

The Code of Practice applies to all water treatment plants where fluoridation of public drinking water supplies, using hydrofluosilicic acid as the fluoride source, is, or is intended to be carried out.

# **4. RESPONSIBILITIES**

- 1. The Health Service Executive is responsible for the fluoridation of drinking water supplied through public water supplies.
- 2. Irish Water acts as an agent of the Health Service Executive in fluoridating public water supplies and it is responsible for doing so in line with any legislation or regulations which may be in place and which govern the fluoridation of water supplies.
- 3. The local authority (as agent of Irish Water under its Service Level Agreement) is responsible for implementing this Code of Practice (COP) and related Standard Operating Procedures (SOP). A local fluoridation monitoring committee comprising of membership from the HSE, and the local authority plant engineer/operative (membership should now also include representation from Irish Water) should meet regularly to review the operation of water fluoridation in their area. This is outlined in letters from the Department of Health to the Chief Executive Officers of the Health Boards in 1992 (Mc Loughlin et al 2005, Appendix 5)

4. It is the responsibility of all personnel involved with the fluoridation process to ensure compliance with the Regulations made under the Health (Fluoridation of Water Supplies Act) 1960 and they should be adequately trained (for example the Water Services Training Group (http://water.lasntg.ie/index.asp), or equivalent, provides a one day course on the Fluoridation of Water Supplies).

# **5. SUMMARY OF THE PROCESS**

Although the size and sophistication of water treatment plants varies widely, the fluoridation system employed is broadly similar at all locations, differing mainly in storage and pump dosing capacities. Figure 1 shows a simplified flow-diagram of the water fluoridation process. A brief description of the various stages is given below in sections 5.1 to 5.8.



#### FIGURE 1: FLOW DIAGRAM OF A TYPICAL WATER FLUORIDATION PROCESS

# 5.1 HYDROFLUOSILICIC ACID MANUFACTURE

Hydrofluosilicic acid is manufactured to specifications as set out in regulations made under the Health [Fluoridation of Water Supplies] Act 1960. Detailed specifications for hydrofluosilicic acid can be obtained from the Safety Data Sheet (SDS) or the Certificate of Analysis for the chemical. Some of the most pertinent characteristics are listed below (S.I. no. 272 of 2008 is the European Communities (Classification, Packaging, Labelling and Notification of Dangerous Substances) Regulations 2008 (or subsequent Regulations): Chemical Abstracts Service (CAS) number: 16961-83-4 EC number: EC Number 241-034-8 Hydrofluosilicic acid 10.9% w/w is a clear colourless, liquid free of precipitation, with a pungent odour. Specific Gravity@ 20°C 1.089 to 1.095 Chemical Formula: H2SiF6.nH2O Classification: Corrosive. Risk Phrases (3rd schedule of S.I. no. 116 of 2003): R34 Safety Phrases: (4th schedule of S.I. no. 116 of 2003): S1/2, S26, S27, S45.

# 5.2 HYDROFLUOSILICIC ACID DELIVERY

Depending on the size of plant storage facilities and usage, acid is delivered by road tanker at intervals ranging from monthly to annually. The acid is transferred to water treatment plant bulk storage tanks by hose.

# 5.3 HYDROFLUOSILICIC ACID STORAGE

Bulk storage on site must be in suitable tanks (e.g. high-density polyethylene or in rubber lined steel tanks), with capacity for at least one month's supply. These tanks may be housed in a building or outdoors and bunded.

Tanks in-situ should be labelled as per the Safety Health and Welfare at Work General Application Regulations 2007 Chapter 1 part 7 - Safety Signage

# **5.4 DAY TANK**

The purpose of the day tank is to guard against the possibility of the entire contents of the bulk storage tank (i.e. up to several months dosage) accidentally discharging into the water supply the bulk storage tank is connected to a day tank (intended to contain one or, at most, a few days dosage capacity) which is normally refilled daily from the bulk storage tank, by plant personnel. This is done by opening a fill-valve on a pipeline connecting the bulk storage tank to the day tank. Day tanks are normally positioned in a bund on weighing scales to enable plant personnel to calculate the weight of acid used each day and hence the expected fluoride concentration in the drinking water. **(See also Section 6.3.2)** 

#### **5.5 FLUORIDE DOSING PUMP**

The day tank feeds the fluoride dosing pump, which is typically an electronic diaphragm- type pump. This operates on the principle that an electronic signal, e.g. from a water flow-meter, attracts an armature to which the pump diaphragm is connected. This results in a specific quantity of acid being dosed from the pump (i.e. pulse dosing). Both stroke length (i.e. the quantity dosed during each pulse) and speed (i.e. rate of pulses per minute) can be adjusted in most pumps. Pump stroke is normally set at 60% and externally controlled across the speed/milliamp range from the flow meter. Minor adjustments can then be made by adjusting the stroke setting.

There are also digital dosing pumps that do not have separate stroke adjustment i.e. a single push button is used to vary the output (normally displayed in litres per hour). Dosing pumps can operate in either 'manual' or 'external' mode. In manual mode, stroke (where adjustable) or speed settings can be adjusted by the plant operator as required. Such a mode has been used mainly when plant water output is constant or does not fluctuate greatly, hence frequent adjustments should not be required. The pumps must also be operated in 'manual' mode during calibration.

External mode adjustment, on the other hand, is triggered by an electronic signal, for example in flowproportional dosing, the dosing pumps receive an electronic signal proportional to the plant water flow rate as measured by a flow-meter. An increase in water flow therefore causes a proportional increase in the fluoride pump dose rate, and vice versa for decreased water flow rate.

Dosing pumps are situated adjacent to the day tank as they operate by vertical suction.

#### **5.6 FLUORIDE INJECTION**

From the dosing pump the acid travels through a length of tubing/pipe-work to the injection point into the water. Ideally this should be at a location with significant turbulence in order to maximise mixing. The injection point for fluoride generally occurs after all of the other treatment processes in the plant.

#### **5.7 SERVICE RESERVOIR**

In most, but not all, water supply systems, in order to ensure reasonably constant water pressure and to be able to meet peak demand, the water is pumped to service/storage reservoirs, with capacities ranging from a few hours to a few days, before supply to the consumer. The relevance of this to fluoridation is the buffering effect that this would be likely to have on fluoride overdosing or under dosing. It also influences, by its capacity, the length of time required to return to optimal levels.

# **5.8 CRITICAL CONTROL POINTS IN THE FLUORIDATION PROCESS**

Hazard Analysis Critical Control Points (HACCP) is a risk management tool in widespread use in the food industry. In essence it involves conducting a risk assessment of a process to identify the critical control points (CCPs) that are crucial to product safety; defining acceptable limits at these points and implementing appropriate controls, monitoring, corrective actions and verification to ensure that the process is under control at all times. As the fluoridation process has the aim of supplying a product with a defined fluoride concentration, the HACCP approach can usefully be applied to it. Table 1 below summarises the hazards, CCPs, critical limits, controls and corrective actions that apply.

CCP NO.	CCP HAZARD	SOURCE OF HAZARD	CONTROLS	CRITICAL LIMITS1	CORRECTIVE ACTIONS
1	Variance from standard of hydrofluosilicic acid delivered (contaminants)	Lack of control during manufacturing	Certificate of Analysis must be checked on arrival/delivery	European Standard I.S. EN 12175:2013	Notify supplier; notify HSE
2	Variability in strength of hydrofluosilicic acid on arrival at treatment plant	Lack of control during manufacturing	Good manufacturing practice to ensure 10.9% strength ± 0.3% Certificate of Compliance from supplier Monitoring as per Protocol for the Independent Testing of hydrofluosilicic acid (Appendix 5)	10.6 – 11.2% strength hydrofluosilicic acid	Notify supplier; notify HSE; Adjust dosing in plant to allow for variation in strength of acid as per protocol for the Independent testing of hydrofluosilicic acid (Appendix 5)
3	Variation in fluoride concentration of water source used for abstraction	Natural background fluoride fluctuation. Contamination by hydrofluosilicic acid spillage/ leak from treatment plant	Monitor & allow for in-dosing calculations. Plant security, construction of tanks, pipes & equipment from suitable materials; Access for leak detection; secondary containment of leaks /spillages; Appropriate siting; Suitable fill valves	0.8mg/l F in water supplied to consumer <sup>1</sup>	See corrective actions protocol Table 2 , section 6.6.4 of this code of practice
4	Fluoride pump overdose / underdose	Dose rate incorrectly set or adjusted Lack of system interlock Siphonage Excessive day tank capacity Malfunction of control systems	Training, calibration, interlock between water flow & F dosing; Anti-siphonage valves; Reduce day tank capacity; regular monitoring of F conc. in water	0.6 – 0.8 mg/l F in treated drinking water <sup>1</sup>	See corrective actions protocol Table 2 , section 6.6.4 of this code of practice
5	Inhalation or skin / eye contact with hydrofluosilicic acid	Tank filling operations; Checking pipes, tanks and pumps. Consideration to the CCP hazard of loss of containment, source of hazard could possibly be defective equipment. Controls may include proper design equipment, preventative maintenance schedule, inspections, bund integrity testing etc	Proper design of equipment; Training; personal protective equipment; safe work procedures	Airborne conc. max of 2.5 mg/m3 (as F) is an OELV (time weighted average over an 8 hour reference period)	See section 10 of this code of practice

#### TABLE 1: HAZARD ANALYSIS CRITICAL CONTROL POINTS IN DRINKING WATER FLUORIDATION

# 6. DOSING INSTALLATIONS AND PROCESS CONTROL - TECHNICAL SPECIFICATIONS

There should be a regular maintenance programme for bulk tanks, day tanks and pipework.

# **6.1 SITE SECURITY**

#### 6.1.1 PREVENTION OF UNAUTHORISED ACCESS

Perimeter fencing, gates and piers should be capable of keeping out would-be intruders. Bulk hydrofluosilicic acid storage tanks and associated pipework sited outdoors should also be enclosed by suitable security fencing, which should also be capable of preventing accidental impact damage from delivery or other vehicles. Plant buildings should have secure doors and windows.

#### 6.1.2 ALARM SYSTEMS

All sites not staffed continuously 24 hours a day, 7 days a week should be fitted with suitably monitored intruder alarm systems.

## 6.2 DELIVERY AND BULK STORAGE OF HYDROFLUOSILICIC ACID

#### 6.2.1 DELIVERY TO WATER TREATMENT PLANT

The design and structural integrity of delivery vehicles and transportation of hydrofluosilicic acid to the water treatment plant should be in accordance with the provisions (including any subsequent amendments) of the European Communities Carriage of Dangerous Goods by Road and Use of Transportable Pressure Equipment Regulations 2011 (S.I. no. 349 of 2011) as amended by S.I. no. 238 of 2013. These regulations give effect to the European International Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). There must be safe access for transfer of bulk quantities of hydrofluosilicic acid from the delivery vehicle to the water treatment plant bulk storage facility. In the case of a small number of fluoridation plants where there are difficulties for access by articulated trucks, delivery may need to take place by rigid truck using industrial bulk containers (IBCs) suitable for hydrofluosilicic acid, UN1778 Class 8 Packing group II. In all cases, the coupling point between the tanker delivery hose and the bulk storage tank fill point must be in a bunded area so that any spillages can be contained and collected for safe and environmentally acceptable disposal.

It is recommended that "stand" pipes (filler pipes) be provided at the waterworks as it will allow for easy coupling of the tanker hose. The "stand" pipes should be located at ground level, be suitably identified, bunded and secured.

It is necessary to ensure that there is sufficient capacity in the bulk tank to accommodate the volume of hydrofluosilicic acid in the delivery. Reliance must not be placed on tank recorders and level displays alone; these readings should be cross-checked against the usage records for the daily transfers to the day tank.

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The tank should not be filled above 90% capacity. It is recommended that a reliable audible and visual alarm is calibrated and maintained to indicate that the tank is full.

All tanks should have a fill pipe with non-return valve, with the fill nozzle accessible at low level. Drip containment is required if this nozzle is not within the tank bund.

Deliveries should only take place under the supervision of, and in the presence, for the entire duration of the operation, of a competent staff member from the water treatment plant who should ensure that the correct chemical has been delivered by checking the documentation. Both delivery and reception personnel must be adequately trained (see section 9 Training of Personnel).

#### 6.2.2 CONSTRUCTION, CAPACITY AND LOCATION OF TANKS

Each fluoridation plant should have a minimum bulk storage capacity of one month's supply of hydrofluosilicic acid. Each plant should have a procedure in place to ensure that replenishment orders are placed in sufficient time to avoid on-site chemical supply being exhausted. Daily visual (or telemetric, where provided) checks should be carried out on the chemical level in the tank and on the tank and bund area for evidence of leaks and such checks should be documented (e.g. on a standard checklist) and records retained on-site. Bulk storage tanks should be constructed of a suitable acid-resistant material e.g. high density polyethylene, rubber-lined metal. An overflow pipe discharging into the tank bund should also be fitted.

New tanks should have fill-points designed to prevent filling with any material other than hydrofluosilicic acid.

At the time of installation and commissioning of the tank, the expected working lifetime of the tank should be ascertained and recorded, with a view to having a replacement schedule in place.

The tank should be labelled with the name of the chemical and appropriate hazardous warning symbols and also the volume of the tank.

If tanks are sited outside, the tank, bund and associated pipework should be adequately secured against accidental impact damage or vandalism. It is also desirable that these external tanks be roofed to exclude as much rainwater as possible from the bund.

Tanks should be so sited that all parts of the outer tank surface are accessible for visual inspection for leaks. In order to facilitate measuring the quantity to be filled from delivery tanker, an easily readable graduated contents level indicator with high and low level alarms should be fitted to all bulk storage tanks. It is important that the draw-off point (for supplying the day tank) from the bulk tank should be situated close to the base of the tank, otherwise the effective capacity of the tank will be reduced.

#### 6.2.3 BUNDING

In order to safely contain the hydrofluosilicic acid, should a leak occur, the bulk storage tank should be accommodated in an acid resistant bund capable of accommodating at least full capacity.

Bunds should be regularly inspected for the build-up of liquid (such as rainwater, in the case of tanks sited outside) and should be periodically emptied, by pumping (as there should be no outlet valve from the base of the bund), when required. The capacity of the bund should not be compromised by liquid retained in the bund from other sources such as rainwater. Drainage from bunded areas should be diverted for collection and safe disposal. The contents of a bund should only be discharged to a surface water drain where Irish Water is satisfied that there is no potential for pollution of the receiving waters from the discharge. The water should be tested for fluoride content prior to discharge.

All bunded areas should be integrity tested in accordance with BS8007 prior to commissioning and thereafter should be retested every 5 years in accordance with the guidelines set out in the EPA Publication "Storage and Transfer of Materials for Scheduled Activities".

#### 6.2.4 LIGHTING

Suitable and sufficient artificial lighting should be provided to enable inspection of all parts of the tank, pipework and bunding for leaks and for reading of the contents level indicator

#### 6.2.5 VENTILATION

Where tanks are sited indoors, the tanks should be closed and there should also be a ventilation pipe discharging direct to the outside of the building at the top of the tank.

# 6.3 DAY TANK

#### 6.3.1 CONSTRUCTION

The tank should be constructed of a suitable acid-resistant material. To allow visual assessment of the level of acid in the tank, it should either be translucent, with an easily readable graduated volume scale on the tank exterior, or have a suitable alternative contents volume indication system. The fill-pipe into the day tank should be sited so that it cannot impede movement of the weighing scales, as this may affect accuracy of weighing.

#### 6.3.2 FILLING FROM THE BULK TANK

It is recommended that the day tank be filled by pumping from the bulk storage tank rather than by gravity filling. Where gravity filling is still in operation a risk assessment should be carried out and it should be phased out as soon as possible. In the interim, pending provision of pump filling, a risk assessment should be carried out as to whether the plant has a spring lever control and whether it should cease fluoridating until it has been corrected. In the absence of a suitable fully automated system, the button to operate the pump should be sited in clear view of the day tank. In order to prevent the pump being inadvertently left running the pump should have a 'dead man's handle' type operation, in other words it should only be possible to activate the pump while the button is held pressed in place by a plant operative.

In the case of a fully automated system the day tank must be fitted with a high-level alarm system which will automatically stop the filling process when the alarm is triggered.

To address possible failure of the high level alarm it is essential that the automated fill system be configured so that no more than the capacity of the day tank can be filled automatically during a fill process.

It is recognised that a large number of fluoridation plants have used gravity filling for many years with no evidence of adverse incidents. However, gravity filling represents a hazard and should be phased out at the earliest opportunity. Pending this, gravity filling in existing plants should only continue, provided that the fill valve has a spring lever (i.e. dead man's handle) which will ensure that it can only fill while a plant operative is physically pressing the button and can observe the acid level in the day tank.

#### 6.3.3 CAPACITY

Day tank capacity needs to be minimised in order to reduce the potential for overdose from siphonage or dosing pump malfunction. Nevertheless, some compromise is required to reduce risk of underdosing (e.g. in the case of small plants not staffed on a 24 hour, 7 day basis, if plant were not visited each day, one day's capacity of HFSA in day tank would not be sufficient). A maximum of 3 days capacity will suffice in all cases but it must be stressed that the maximum capacity be as close to that sufficient to treat one day's maximum water output for the plant as practicable. It is also important to ensure that the level in the day tank does not become too low as this can cause an air-lock in the system. Where existing day tanks have capacities in excess of 3 days usage, a clearly identifiable and indelible maximum fill line (not exceeding 3 days capacity) should be affixed to the tank and a procedure implemented and monitored to ensure that filling above this line does not take place (incorporation of a high-level alarm would be one option). If the procedure is not / cannot be adhered to, the tank should be replaced by one of appropriate capacity.

#### 6.3.4 VENTILATION

The day tank should be sealed and have a ventilation pipe direct to the outside air. This pipe should be able to accommodate day tank movement on the weighing scales. Having regard to requirements of the Health and Safety Regulations, adequate mechanical exhaust ventilation (i.e. capable of ensuring that the airborne concentration of fluoride, in the vicinity of the day tank does not exceed 2.5 mg/m<sup>3</sup> (as a time weighted average over an 8 hour reference period))immediately adjacent to the tank would be acceptable and automated activation of extractor when the door to the day tank room is opened.

#### 6.3.5 LIGHTING

Suitable and sufficient artificial lighting should be provided to enable inspection of all parts of the tank and pipework for leaks, for reading of the contents level of the day tank, weighing the tank contents and for all activities associated with operation and maintenance of the fluoride dosing pumps.

#### 6.3.6 BUNDING

In order to safely contain the hydrofluosilicic acid, should a leak occur, the day tank, fluoride dosing pump and standby pump should be accommodated in an acid resistant bund capable of accommodating at least full capacity of the tank. Bunds should be regularly inspected for the build-up of liquid and should be periodically emptied, by pumping (as there should be no outlet valve from the base of the bund), when required. The capacity of the bund should not be compromised by liquid retained in the bund from other sources. Drainage from bunded areas should be diverted for collection and safe disposal.

All bunded areas should be integrity tested in accordance with BS8007 prior to commissioning and thereafter should be retested every 5 years in accordance with the guidelines set out in the EPA Publication *"Storage and Transfer of Materials for Scheduled Activities"*.

# **6.4 FLUORIDE DOSING PUMP**

#### 6.4.1 LOCATION

The dosing pump will normally be sited adjacent to the day-tank and should be contained within the same bund. The pump should not be sited more than 1.2 metres above the lowest normal level of the contents of the day tank and should operate on suction lift.

#### 6.4.2 DOSING SAFEGUARDS (INTERLOCK / SCADA)

Flow-proportional dosing should be the normal practice at all plants i.e. the pulse rate of the dosing pump will be governed by an electrical signal which varies according to the water flow rate as measured by a flow meter. To prevent overdosing the dosing pump should incorporate some form of safeguard protection. This may vary depending on the size of treatment plant. The safeguard should be by interlock of the dosing pumps with the mains water pump or control by a SCADA system.

Dosing pumps should be hard wired in order to prevent by-pass of controls. Pumps should incorporate an audible alarm to indicate when the pump is operating in manual mode (the pumps must be switched to manual mode for calibration – see 6.4.6 below) and the system should be locked to prevent mode switching by unauthorised personnel. At commissioning of new pumps, flow-meters, system components or a power cut, a trial should be carried out to assess the effect on dosing pump default setting.

#### 6.4.3 PUMP OUTPUT AND ACCURACY

The installations are to be capable, under unqualified guarantee, of operating within an accuracy of ±3%. As dosing accuracy falls off, in the case of separate stroke adjustment pumps, when the pump is operating below 30% and above 70% capacity, consideration should be given (where such types of pumps are in use) to an automatic dose cut-off if, for any reason, plant output enters this range. This does not apply in the case of digital dosing pumps which do not have a separate stroke adjustment and can operate accurately at lower pumping capacity.

To optimise dosing accuracy and minimise the magnitude of any potential overfeed, the pump should be chosen so that, based on the typical range of the volume of water treated, it will not be expected to operate at speed/stroke settings of less than 50%, or greater than 70%, of maximum pump capacity. A pump delivering the optimal fluoride dose while operating at 70% pump capacity would deliver roughly one and a half times

the optimal fluoride dose if it were, for any reason, to operate at maximum pump capacity treating the same volume of water.

Where dosing pumps display the pump throughput in litres per hour this can be used to provide a ready method for a rough calculation of the concentration of fluoride being dosed where the volume of water treated is relatively constant e.g. dosing at 1 litre per hour for every 120 m<sup>3</sup> throughput of water should give a fluoride concentration close to 0.7 mg/l

#### 6.4.4 ANTI-SIPHONAGE AND BACK-FLOW PROTECTION

The dosing system should in all cases be fitted with back pressure, anti-siphon and pressure relief valves.

#### 6.4.5 DUTY / STANDBY DOSING PUMPS

Duty/standby fluoride dosing pump arrangements should be provided at all plants to prevent a situation where under dosing/no dosing occurs due to a pump malfunction.

It is vital that system wiring should ensure that both pumps cannot be operated simultaneously as this could result in twice the intended dose of fluoride in the water.

#### 6.4.6 SERVICING AND CALIBRATION

There should be a documented programme of servicing and calibration of fluoride dosing pumps (at least annually, but more frequently if necessary e.g. after repairs, replacement, potential damage, dosing results outside specification with no apparent explanation). It is also recommended that in-house calibration of dosing pumps is carried out in compliance with the manufacturer's instructions. All variable stroke dosing pumps must be switched to manual mode when being calibrated by service personnel where the quantity of hydrofluosilicic acid pumped in a given time is measured, using a graduated tube and stopwatch, at different speed/stroke settings. It is important that the pump is restored to external mode by the service personnel once calibration has been completed.

Suppliers of dosing pumps, following service checks, should leave a documented record of checks carried out on site, including confirmation that the pump has been restored to external mode operation, following calibration. These checks should include the adequacy and functionality of anti-siphonage features as well as pump calibration.

It is recommended that all new pump installations should be fitted with burette type valved calibration gauges. Regular calibration (at least annually) of water flow-meters should also be carried out and documented. All calibration and servicing records should be retained on-site for inspection for the lifetime of the equipment.

# **6.5 FLUORIDE DOSING SYSTEM PIPEWORK**

#### 6.5.1 ACCESSIBILITY FOR LEAK DETECTION AND IDENTIFICATION

Pipework carrying hydrofluosilicic acid should, as far as possible, be readily accessible for visual inspection for leaks. All pipework carrying hydrofluosilicic acid should be clearly distinguishable from other plant pipework by use of colour coding and labelling.

Underground piping should be enclosed in a sloped conduit with an inspection chamber downslope for detection of hydrofluosilicic leaks.

All pipework should be located to prevent accidental impact damage and with regard to electrical safety considerations.

Where more than one water supply source is being fluoridated at a water treatment plant, hydrofluosilicic acid pipework for each system should be readily distinguishable. Routine maintenance should include colour coding and labelling with directional flow arrows to prevent misconnection during commissioning, servicing or repair.

#### 6.5.2 DOSING POINT

In order to ensure adequate mixing, the injection point should normally be located at a point where all of the water to be treated passes under constant positive pressure. The injection point should, where possible be located in the lower third of the pipe and the end of the injection line should extend one-third of the water pipe diameter.

In water supplies using sources containing iron or manganese, blockages may be encountered due to precipitation as a result of oxidation at the injection point.

# **6.6 MONITORING AND CORRECTIVE ACTIONS**

It is a requirement that daily measurement of the fluoride content of the treated water takes place at the treatment plant (S.I. 42 of 2007) This requires adequate staffing resources and reliable test methods to ensure that prompt corrective action is taken.

In addition to training on the specific test methodology, plant personnel should also receive training and information in relation to health and safety aspects of test procedures and reagents used and appropriate storage and disposal of reagents, samples etc.

#### 6.6.1 AUTOMATED ON-LINE MONITORING

In certain circumstances, for example in treatment plants with a high level of automation and computerised process control, or for plants treating waters with significant variations in natural background fluoride levels

(where 'feedback' trim dosing is advisable, and is recommended by the EPA) the use of an automated in-line fluoride monitoring system may be advantageous and should be installed where practicable. It is recognised that many fluoridation plants using manual monitoring have achieved consistently excellent results over several years; hence the continued use of manual monitoring is deemed acceptable, providing the recommendations of 6.6.2 below are followed in full. In plants with in line monitoring (ion selected probe), it must be validated by volumetric testing.

#### 6.6.2 MANUAL MONITORING

In plants where there is no automated on-line monitoring and recording there should be daily fluoride concentration measurement supplemented by 'volumetric' testing carried out by a member of the water treatment plant laboratory staff trained in the use of the testing methods.

#### 6.6.2.1 COLORIMETRIC TESTING

Colorimetric fluoride testing equipment at water treatment plants should be analogue or digital display specification, as this system is less subjective than visual comparison with standard colour discs. Allowance must be made for potential confounding interferences with analysis accuracy, for example a temperature differential between sample 'blank' and sample is of critical importance. It is recommended that the necessary steps be taken to ensure that the test procedure complies with the standard operating protocol so that standards and blanks are at the same temperature as the samples. The presence of interfering substances such as aluminium should also be taken into consideration. It is recommended that operatives refer to the chart of interfering substances (SPADNS) regarding this. (See Appendix 6)

Where on-line automated fluoride concentration testing systems are operational there may be no need for a manual colorimetric testing programme to be carried out as well. This depends on the calibration stability of the on-line system.

#### 6.6.2.2 DAILY WEIGHT VOLUMETRIC MONITORING

This should be carried out on a daily basis unless there is a suitable automated data acquisition and recording system in place. Alternative methodologies which provide equivalent assurance should be documented. It is not enough to carry out volumetric measurement on its own, in the absence of direct measurement of the fluoride content of the water. The day tank is weighed at the same time each day (both prior to refilling and following refilling) and the pre-fill weight subtracted from the previous day's post-fill weight to give the weight of hydrofluosilicic acid used. The following formula is then used to calculate the theoretical concentration of fluoride in the treated water:

Fluoride conc. (mg/l) =   

$$\frac{\text{kg acid x strength of acid expressed as a fraction x 790}}{\text{m}^3 \text{ water treated}}$$

This figure should be recorded and checked against the manual colorimetric or online test result and any discrepancy investigated. The weighing scales should be calibrated, at least annually, or at more frequent intervals if shown to be necessary.

#### 6.6.2.3 MONITORING OF NATURAL BACKGROUND FLUORIDE LEVELS

As some water supply sources can contain low levels of naturally occurring fluoride, which may need to be allowed for in dose calculations, a number of samples of source water should, where historical results are not available, be tested over the course of a year in the case of all supplies to obtain a profile of the background fluoride level. The test methodology for these samples should ideally to be of sufficient sensitivity to detect levels as low as 0.05mg/l F.

The frequency of future source water background fluoride testing should be based on findings of the profiling samples and on the plant's consistency of compliance with fluoride levels in treated drinking water but it is suggested that it would be worth taking samples at least twice a year (at different times of the year) from all supply sources as a matter of routine.

#### 6.6.3 RECORDING AND REPORTING OF MONITORING RESULTS

#### 6.6.3.1 TESTING AT PLANT

All results should be recorded by the person carrying out the tests and be available for inspection by the responsible area engineer or designate, by officers of the Health Service Executive and by the Environmental Protection Agency. Automated data acquisition and recording systems (LIMS) may be used to comply with this recommendation. A copy of the results should be forwarded in a timely manner if requested by the Health Service Executive. Non-conforming results should be notified in accordance with the procedure, and within the timescale, outlined in Table 2 in section 6.6.4 below. Copies of all test results should be retained on site or in electronic format (LIMS) for inspection.

It is important to record and report non-compliant results as this indicates that there is an issue with dosing levels on a once off or continuing basis. If non-compliant results are not recorded and reported then it will not be known whether it is a once-off event or if there is a pattern.

#### 6.6.3.2 MONTHLY MONITORING AND REPORTING

Each fluoridated water supply should be sampled monthly at consumers' taps at locations representative of the fluoridated supply by staff of the Health Service Executive for analysis by the Public Analyst Laboratories. Non-compliant results should be reported promptly to the relevant responsible area engineer or designate and action taken in accordance with the protocol set out in Table 2 below.

Results for each quarter of the year should be presented to the local Fluoridation Monitoring Committee for its review. The local Fluoridation Monitoring Committee should report any concerns to the National Fluoridation Steering Committee.

#### 6.6.4 CORRECTIVE ACTIONS

Immediate action should be taken to investigate the cause of abnormal results or non-compliant results and to institute appropriate corrective action. The protocol set out in Table 2 below has been adapted from Table 1 of the U.S. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report Recommendations and Reports Engineering and Administrative recommendations for Water Fluoridation (1995) and has been modified to take account of: European Communities maximum parametric value (i.e. maximum acceptable limit for lifetime exposure) for fluoride in drinking water (= 1.5 mg/l) as set out in Council Directive 98/83/EC or 3rd November 1998; World Health Organisation publication 'Fluoride in Drinking Water' (Fawell, J., Bailey, K., Chilton, J., Dahi, E., et al, 2006) and a literature review of fluoride concentrations in drinking water associated with acute toxic effects (Parle, 2001).

The protocol is primarily intended to apply in relation to results of water services authority on-line or daily colorimetric monitoring carried out at the water treatment plant. In interpretation of results it should be noted that all methods of analysis carry an inherent measurement uncertainty which means that if the measurement uncertainty associated with a particular test method is ±10%, a stated result of 0.80 mg/l means in effect that the actual concentration of the substance lies somewhere between 0.72 mg/l and 0.88mg/l. While this is of relevance in assessing the significance of marginal non-compliances it must be borne in mind that neither European Communities drinking water legislation nor Irish fluoridation legislation allow for application of measurement uncertainty.

# **TABLE 2: FLUORIDATION NON-CONFORMANCE PROTOCOL**

#### NOTES:

- 1. For any non-conforming result, the first step should be to retest immediately
- 2. To determine whether a result is compliant, the result should be approximated to one decimal place e.g. 0.82 should be rounded down to 0.8; 1.06 should be rounded up to 1.1 and so forth. This approach is in keeping with part 3, section 2 of the schedule in the European Union Drinking Water regulations 2014 S.I. 122 of 2014, where it is stated: '........the result must be expressed using at least the same number of decimals as for the parametric value considered in Tables B and C in Part 1 of the Schedule.'
- The parametric value for fluoride in table B of the schedule is given to one decimal place (0.8 mg/l)
  3. Under the Drinking Water Regulations the Water Services Authority is required to notify IW and the EPA in the event of a non-compliance. Section 4 of Chapter 6 of the EPA Handbook (http://www.epa.ie/pubs/advice/drinkingwater/publicwatersupplieshandbook/) contains specific requirements about the notification to the EPA of fluoride non-compliances.

In cases where fluoride result exceeds 1.5 or where there are multiple exceedances notify the EPA. The water suppliers must notify the EPA using the Online Drinking Water Notification System (http://web.epa.ie/odwn/login.aspx) within 24 hours. The process for notifying the EPA about fluoride exceedances is explained in detail in the EPA Drinking Water Handbook – A Handbook on the Implementation of the Regulations for Water Services Authorities for Public Water Supplies Public Water Supplies Handbook: Environmental Protection Agency, Ireland

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ACTION LEVEL (MG/L F)	ACTION TO BE TAKEN	TIMESCALE
Temporary suspension of fluoride dosing	<ul> <li>(1) Notify Health Service Executive and IW of date of suspension and likely duration</li> <li>(2) Notify Health Service Executive and IW of date of resumption of fluoridation</li> </ul>	<ul> <li>(1) Immediately on becoming aware of suspension or planned suspension</li> <li>(2) Immediately on becoming aware of date of resumption or planned date of resumption</li> </ul>
Less than 0.6 or greater than 0.8 and not greater than 1.0	<ul> <li>(1) Leave system on pending resolution of the problem; water services authority to check validity of sample result and, as appropriate, to determine malfunction &amp; repair or adjust dosing and retest, record details of incident, &amp; corrective action taken.</li> <li>(2) Where the non-conforming result was from a sample taken by the Health Service Executive, water services authority to be notified of unsatisfactory result. A retest should be carried out as appropriate.</li> </ul>	<ul> <li>(1) Take action on becoming aware of result</li> <li>(2) Take action on becoming aware of result. Retest to be carried out within 2 weeks or as appropriate.</li> </ul>
Greater than 1.0 and not greater than 1.5	<ul> <li>(1) Leave system on for not more than 30 days pending resolution of the problem; Water Services Authority to check validity of sample result and, as appropriate, to determine malfunction &amp; repair or adjust dosing and retest, notify details of incident, &amp; corrective action taken, to IW, Health Service Executive (Principal Environmental Health Officer / Principal Dental Surgeon) as soon as possible.</li> <li>(2) Health Service Executive to retest as appropriate. If retest result &gt;1 mg/l shut off fluoridation plant unless IW / Water Services Authority can satisfy HSE that plant is back in conformance</li> <li>(3) Where samples taken by Health Service Executive, IW / water services authority engineer with responsibility for water services to be notified of unsatisfactory results</li> </ul>	<ul> <li>(1) All results greater than 1.0 and ≤1.5 to be notified to Health Service Executive within 3 working days</li> <li>(2) retest within one week of notification by water services authority or as appropriate</li> <li>(3) within 24 hours of receipt of result</li> </ul>

Greater than 1.5 and not greater than 2.0	<ol> <li>Leave system on; water services authority to check validity of sample result and, as appropriate to determine malfunction &amp; repair or adjust dosing and retest; if problem cannot be rectified within 24 hours, IW / water services authority to shut off fluoridation plant until problem resolved</li> <li>IW / Water Services Authority to notify details of incident, &amp; corrective action taken, to Health Service Executive PEHO</li> <li>If Health Service Executive took original sample, notify IW / Water Services Authority to take and record fluoride tests at reservoir outlets and in distribution system</li> <li>Health Service Executive to retest. If follow-up sample still above 1.0mg/l shut off fluoridation</li> </ol>	<ul> <li>(2) As soon as practicable but not more than 24 hours after identification of malfunction</li> <li>(3) As soon as practicable but within 24 hours of receipt of result.</li> <li>(4) For the duration of the malfunction</li> <li>(5) As soon as practicable but not more than three working days after receipt of notification</li> </ul>
Greater than 2.0 and not greater than 4.0	<ul> <li>(1) Unless cause of problem can be immediately identified and rectified immediately, IW / Water Services Authority to shut off fluoridation plant</li> <li>(2) IW / Water Services Authority to notify incident and corrective action taken to Health Service Executive – PEHO and PDS</li> <li>(3) If Health Service Executive took original sample, notify IW / Water Services Authority and senior HSE management of result</li> <li>(4) Water Service Executive to retest</li> <li>(5) Health Service Executive to retest</li> <li>If follow-up sample still above 1.0mg/l shut down system until problem identified and resolved</li> </ul>	<ol> <li>Immediately on receipt of sample test result</li> <li>Immediately on receipt of sample test result</li> <li>Immediately on receipt of sample test result.</li> <li>For the duration of the malfunction</li> <li>Immediately on receipt of sample test result</li> </ol>
Greater than 4	<ul> <li>(1) IW / Water Services Authority to shut off fluoridation plant and notify Health Service Executive immediately; IW / Water Services Authority to take necessary steps to ensure that consumers do not drink the water e.g immediate notification that water must not be consumed / other steps considered necessary. Health Service Executive to satisfy itself that appropriate action has been taken. Fluoridation not to resume until Health service executive satisfied that cause of overdose has been determined and rectified</li> <li>(2) If Health Service Executive took original sample, notify IW / Water Services Authority and senior HSE management of result</li> </ul>	<ul><li>(1) Immediately on receipt of sample test result</li><li>(2) Immediately on receipt of sample test result.</li></ul>

#### Abbreviations: mg/l F: milligrams fluoride per litre of water PEHO: Principal Environmental Health Officer (Health Service Executive) PDS: Principal Dental Surgeon (Health Service Executive) IW: Irish Water

#### 6.7 AUDIT PROGRAMME

In addition to any programme of external audits, each fluoridation plant should be internally audited by either Irish Water or the Water Services Authority or the HSE on an annual basis to determine whether the plant is meeting the required standards as outlined in the Health (Fluoridation of Water Supplies) Act, 1960 or any other relevant legislation as well as the standards as outlined in this code or practice. The results of such audits and any recommendations arising therefrom shall be communicated to the Water Services Authority and the fluoridation monitoring committee.

# 7. COMMISSIONING (AND RE-COMMISSIONING) OF FLUORIDE DOSING PLANTS

Irish Water (IW) should agree criteria for the acceptance of new or refurbished fluoride dosing plants with the Health Services Executive (HSE). This will typically entail a test using un-dosed water (for new plants) followed by a surveillance period of at least 30 days in-house testing of daily water samples. Fortnightly samples should be taken by HSE staff for verification and submitted to the Public Analyst's laboratory for the first six months following commissioning (Regulation 9, S.I. 42 of 2007). Where a significant component of the dosing system has been replaced or dosing has ceased for more than 30 consecutive days, the plant operator should prepare an appropriate re-commissioning plan.

## 8. DECOMMISSIONING OF FLUORIDE DOSING PLANTS AND EQUIPMENT

The decommissioning and removal of fluoride dosing plant and equipment should take into consideration all relevant legal requirements, including those relating to Health & Safety, construction/demolition and waste disposal. Any decommissioning activity should include the preparation of a site specific assessment of the activities to be undertaken. This should be documented and agreed by IW, the local authority and the HSE.

#### 8.1 REMOVAL & DISPOSAL OF FLUORIDATION CHEMICALS

Prior to any removal of the fluoridation chemical off-site (except via existing bulk transfer arrangements that may be employed as part of normal fluoridation operations), water undertakers must ensure that the fluoridation chemical storage and dosing equipment is physically isolated from the treatment process/water supply.

Prior to decommissioning, the volume of fluoridation chemical present at the installation should be reduced to a minimum. The arrangements for the reduction in stored volumes of chemicals should form part of the documented site specific assessment, and should consider the following options

#### 8.1.1 VOLUME REDUCTION VIA EXISTING DOSING ARRANGEMENTS

An assessment should be made of the viability of minimising the amount of bulk storage chemical to be disposed of off-site by continuing existing dosing in a controlled manner. Particular attention should be paid to the age, safety and reliability of equipment to be used and appropriate additional safeguards employed.

#### 8.1.2 TRANSFER OF CHEMICALS TO ALTERNATIVE SITES

Where the reduction in stored chemical via controlled dosing is not possible, a reduction in the stored volume may be possible via transfer to an alternative fluoride dosing installation. This is only likely to be possible where undertakers routinely utilise specialist equipment to transport fluoridation chemicals between sites. This should comply with Regulations for transport and disposal and careful consideration should be given to the health and safety implications of any non-routine chemical handling operations.

#### 8.1.3 DISPOSAL VIA AN APPROPRIATE WASTE CONTRACTOR

Where it is not possible to minimise the volume of fluoridation chemical by the above means, or where a residual amount remains after partial storage reduction, the fluoridation chemical should be disposed of via an appropriate licensed waste contractor. The potential long term effects of environmental exposure to the fluoridation chemical should be evaluated as part of the waste disposal options considered. Careful consideration of the waste classification (European Waste Code) will be required to ensure appropriate disposal control measures are employed.

This may involve the classification of fluoridation chemicals and/or materials that have been in contact with the fluoridation chemicals being considered as hazardous waste.

The waste should only be transported from the treatment plant by an authorized waste collector. In this regard the transporter of the waste must hold a Waste Collectors Permit in accordance with the Waste Management (Collection Permit) Regulations, 2001 (SI No. 280 of 2007) as amended by SI No. 87 of 2008. The permit must be valid for the period the waste is to be transported, must allow the permit holder to transport the waste type in question and must be valid for the area the waste is to be transported to/from. If in doubt the Waste Section of the Water Services Authority should be contacted to verify the status of any potential waste collector. Once collected the waste must be transported to an EPA Licensed facility for disposal/ recovery. The EPA licensed facility must be permitted to accept the waste type in question. Details of the license can be verified by examining the conditions of the license on the EPA website (http://www.epa.ie). In conjunction with EPA requirements, waste is also liable to the ADR regulations and the provisions of packing, loading, transporting and unloading must also be adhered to.

# 8.2 REMOVAL OF PLANT AND EQUIPMENT (TANKS, PIPEWORK, PUMPS, MONITORING EQUIPMENT)

All redundant material and equipment which has been subject to long term exposure to the fluoridation chemicals should be removed and disposed of in an appropriate manner. Equipment to be disposed of is likely to include (but is not limited to) the following:

- Chemical delivery pipework and equipment
- Storage and holding tanks and associated equipment (including saturators for powder installations)
- Chemical transfer equipment and pipework
- Pumps
- Dosing lines & dosing point installations

- Electrical equipment exposed to fluoridation chemicals or residues (including cable trays, ducts)
- Monitoring and telemetry installations associated with the fluoride dosing plant

The equipment to be removed and disposed of should be agreed on a site-by-site basis between IW/the Water Services Authority and the HSE.

Consideration should also be given to the future use of any buildings and land areas specifically associated with the fluoridation installation.

As with disposal of the chemical itself, the disposal of plant and equipment should be subject to an assessment of the potential long term effects of environmental exposure and careful consideration of the waste classification (EWC) will be required to ensure appropriate disposal control measures are employed.

This may involve the classification of materials that have been in contact with the fluoridation chemicals being considered as hazardous waste.

## **8.3 INTERACTION WITH EXISTING TREATMENT PROCESSES/OPERATIONS ON SITE**

Any decommissioning of fluoridation plant and equipment should include a documented assessment of the likely impact on continuing operational activities at the site concerned. This assessment should also include detail of the actions to be taken to safeguard the quality of treated water leaving the site during and after the decommissioning process.

This assessment should consider (but not be limited to):

- The impact of the cessation (temporary or permanent) on water quality, e.g. a reduction in the amount of pH depression as a result of stopping acid dosing
- The impact of the cessation (temporary or permanent) on treatment processes employed at or near to the site, e.g. variation of other treatment processes, such as coagulation, pH correction
- The impact on control loops, in particular where flow measurements are also used in the control of other dosing or control systems
- The impact of changing carrier water flows and/or characteristics
- The impact of changes to telemetry, alarms and electrical systems resulting from the isolation and/or removal of the fluoridation equipment.

# 9. TRAINING OF PERSONNEL

Staff involved in the operation and maintenance of fluoride dosing installations shall receive specific training in fluoridation issues. All fluoridation plant personnel (both temporary and full-time) shall, before commencing duties relating to water fluoridation, receive this appropriate training. It is recommended that personnel receive refresher training at defined intervals (e.g. every 5 years).

# 9.1 TRAINING PROGRAMME CONTENT

The training programme should as a minimum include instruction and the demonstration of competence in the following areas:

#### 9.1.1 FLUORIDATION - AN OVERVIEW

This would include the public health rationale for fluoridation and the importance of dosing at optimal levels.

#### 9.1.2 FLUORIDATION DOSING - PROCESS AND PRACTICAL ASPECTS

A detailed examination of all parts of the process and the trainees role in this, in particular, chemicals used, procedures for delivery of acid to plant, transfer to day tank, operation and maintenance of dosing equipment; legal limits on fluoride content in fluoridated water test procedures (colorimetric/volumetric/ automated monitoring) and their limitations.

#### 9.1.3 CORRECTIVE ACTION PROCEDURES

It is imperative that those most likely to be the first to become aware of a dosing problem be fully conversant with the actions required to be taken and that lines of communication and contact details are brought to their attention during this training. This training should also cover dealing with spillages.

#### 9.1.4 SAFETY MEASURES

It is essential that trainees are made fully aware of the hazards to their personal health and safety from hydrofluosilicic acid. A copy of the safety data sheet for hydrofluosilicic acid and chemical test reagents should be given to each trainee. Training should be given in safe work practices covering all aspects of the process, use of personal protective equipment, emergency procedures in the event of accidental contact with or ingestion of acid.

#### 9.1.5 ENVIRONMENTAL PROTECTION:

Safe containment and disposal of spillages should be covered during training.

#### 9.2 TRAINING RECORDS

Records of all training and competence assessment should be maintained of all staff operating fluoride dosing installations.

# 9.3 PLANT PERSONNEL HEALTH AND SAFETY

The employer and the employee must comply with the Safety, Health and Welfare at Work Act 2005 and all other applicable legislation.

All employees including plant operators, plant engineers, Directors of Water Services and relief and holiday workers must receive health and safety training related to water fluoridation. Induction training must be

completed before any new member of staff operates, adjusts or maintains the fluoridation system or receives deliveries of hydrofluosilicic acid. Refresher training for all staff must be carried out regularly or whenever a new hazard is introduced into the operation of the treatment plant. All training must be documented and signed off by the trainer and trainee.

# 10. HEALTH AND SAFETY ISSUES DISCLAIMER:

Although compliance with the provisions of this section will reduce the risk of injury or ill-health for those working with hydrofluosilicic acid, this Code of Practice does not purport to be a guide to compliance with the Safety Health and Welfare at Work legislation in force in Ireland and should not be interpreted as such. The Health and Safety Authority has responsibility for the enforcement of such legislation and should be contacted with any queries.

# **10.1 RISK ASSESSMENT**

A risk assessment is simply a careful examination of what, in your workplace, could cause harm to people, so that you can determine what precautions or controls are necessary to prevent harm. The aim is to prevent accidents or work-related ill-health in the workplace.

The five steps for carrying out a risk assessment are:

- Step 1: Look out for the hazards
- Step 2: Decide who might be harmed and how
- **Step 3:** Evaluate the risks and decide whether the existing precautions are adequate or whether more should be done
- Step 4: Record your findings
- Step 5: Review your assessment and revise it if necessary

'Hazard' means anything that can cause harm e.g. chemical 'Risk' is the chance, high or low, that somebody will be harmed by the hazard.

All employers and self-employed people have duties under health and safety legislation to assess risks in the workplace. The Safety, Health and Welfare at Work (Chemical Agents) Regulations, (S.I 619 of 2001) specifically obliges employers and self-employed persons to assess the risks arising from the use of, or presence of chemical agents in the workplace.

To comply with the Safety, Health & Welfare at Work (Chemical Agents) Regulations 2001 (S.I. no. 619 of 2001) (hereinafter referred to as 'the Chemical Agents Regulations') or subsequent regulations, a risk assessment of on-site reception, storage and use of hydrofluosilicic acid must be carried out at each location, including monitoring to ensure that the maximum airborne fluoride concentration does not exceed OELV of 2.5 mg/m<sup>3</sup> (as

a time weighted average over an 8 hour reference period). Testing during tank filling operations would probably be indicative of the maximum concentration likely to be encountered.

Occupational exposure monitoring plans should be devised by a trained competent person. Cleaning, maintenance and testing activities are also critical times to monitor and risk assess potential exposure levels. This should be derived from the site specific chemical risk assessment. The risk assessment should also include an examination of testing procedures and reagents. The assessment should be documented and a copy retained on-site.

# **10.2 TRAINING AND INFORMATION**

All relevant plant personnel must, under the Chemical Agents Regulations, receive information and training in relation to all hazards associated with the storage and use of hydrofluosilicic acid and appropriate safe work procedures. Safety data sheets for hydrofluosilicic acid and documented safe work procedures must be available at all plants. It is recommended that the documentation be prominently displayed in an easily readable format on durable material in the bulk storage area and day tank dosing rooms.

# **10.3 GENERAL HEALTH AND SAFETY ADVICE RELATING TO HYDROFLUOSILICIC ACID**

This section provides general guidelines on occupational health and safety precautions to be taken in the use of hydrofluosilicic acid. It does not purport to be exhaustive or to discharge Irish Water from the need to fulfil the requirements of clauses 10.1 and 10.2 above. Information should be obtained from the safety data sheet and transposed into a risk assessment pertaining to the site activities, tasks and site specific information.

#### 10.3.1 GENERAL PRINCIPLES

Treat hydrofluosilicic acid with respect. It is a highly corrosive liquid and will cause severe injury if splashed on the skin or in the eyes, or if taken internally.

When handling hydrofluosilicic acid:

- 1. Always wear acid-resisting clothing, goggles, PVC gloves and acid resistant footwear
- 2. Always have a copious supply of water available
- 3. Always keep an eyewash bottle ready
- 4. Have access to a foot/arm operated face wash and/or shower unit
- 5. Always keep calcium gluconate gel ready

See Appendix 1 for First Aid in the event of contact with hydrofluosilicic acid.

#### 10.3.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

It is the duty of every employer to provide personal protective equipment where required by his employees. The PPE must be suitable for its intended use and comply with relevant European Community Directives. A suitable storage area should be made available so that the PPE can be maintained in good working order and in a satisfactory hygienic condition. PPE provided should be normally used by one employee, where it is necessary for an item of PPE to be worn by more than one employee, the employer shall ensure that such use does not create health or hygiene problems for any user. All employees must receive information, training and instruction on use of PPE.

PPE that is required to be worn when handling hydrofluosilicic acid:

Eye protection: Wear eye/face protection (EN166)

Skin protection: Hand Protection: PVC or other plastic material gloves (EN374). Rubber not recommended.

**Other**: Wear suitable protective clothing (EN13034), chemical resistant apron. If splashes are likely to occur, wear: rubber or plastic boots.

**Respiratory Protection** (RPE): Not normally required. Breathing apparatus must be worn if levels exceed the recommended limit (occupational exposure limit is 2.5mg/m<sup>3</sup>)

**Ventilation Requirements**: Adequate ventilation is essential in buildings where the material is handled and stored.

#### 10.3.3 EMERGENCY WASH AND DECONTAMINATION FACILITIES

It is important that emergency wash and eye-wash facilities be situated immediately adjacent to bulk storage tanks and the day tank room. In this regard, the provision of mobile shower units would be worthy of consideration.

A first aid kit, containing antidote gel, should be provided at each site.

Although ingestion is the least probable exposure route, it is potentially the most damaging, a tin of evaporated milk /calcium gluconate or calcium lactate solution should be maintained in the first aid kit for such eventualities (ensure that a can opener is also provided).

A foot/arm operated face wash and/or shower unit must be provided at each site.

See Appendix 1 for first aid procedure.

Shower units should be constructed and maintained as per I.S. EN 15154-1:2006 (Showers) and I.S. EN 15154-2:2006 (Eyewash).

#### 10.3.4 REPORTING OF INCIDENTS UNDER SAFETY, HEALTH & WELFARE AT WORK LEGISLATION

All accidents or incidents that result in either personal injury or illness, and or damage to equipment, no matter how minor should be properly reported and investigated. Although accident/incident investigation is a reactive process, a comprehensive accident reporting and investigation process is a proactive measure that can effectively prevent or minimize future accidents/incidents.

It is essential that all accidents/incidents are properly reported in a timely manner and that all causes (direct and contributory) are thoroughly identified and that the appropriate corrective action is taken. All of these

details must be recorded on an accident/incident report form. Further details of reporting requirements can be found in Appendix 2

#### **10.3.5 EMERGENCY COMMUNICATIONS**

To effect rapid response to plant personnel injuries or significant fluoride overdoses, telephone/mobile phone facilities should be available at all times at all plants together with a list of emergency contacts.

#### 10.3.6 ENVIRONMENTAL PROTECTION – IN THE EVENT OF A SPILLAGE

Provisions relating to detection and containment of spills or leaks of hydrofluosilicic acid are contained in Appendix 3

It is important that any plant drainage system, installed to contain or remove spillages contaminated with hydrofluosilicic acid, does not discharge to a watercourse.

A quantity of neutralising chemical, e.g. lime, should be maintained at each plant, or be readily available, in order to deal with any acid spillages that may occur. A quantity of dry earth or sand should also be available for absorption of spillages.

Please refer to local major accidents plan where these apply to a hydrofluosilicic acid spillage.

#### 10.3.7 STORAGE OF REAGENTS

Storage of reagents (used and unused) by the plant operator and/or Environmental Health Officer (the use of SPADNS test by some EHOs leaves ampoules to be disposed of) should comply with Health and Safety and protect against leakages or spillages until collection of used goods by licensed hazardous waste contractor.

# **GLOSSARY OF TECHNICAL TERMS**

ACID: A substance that dissolves in water with the formation of hydrogen ions, contains hydrogen which may be replaced by metals to form salt, and/or is corrosive.

ACCURACY: Closeness of a reading or indication of a measurement device to the actual value of the quantity being measured.

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.

ANTI-SIPHONAGE VALVE: A device that prevents back flow.

AUDIT: A systematic and independent examination to determine whether activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives

BUND: A retention facility (including walls and base) built around an area where potentially polluting substances are handled, processed or stored, for the purposes of containing any unintended escape of material from that area until such time as remedial action can be taken.

CALIBRATION: Process of comparing an instrument's accuracy to known standards.

CERTIFICATE OF ANALYSIS: A document certifying results of analysis that was carried out.

CESSATION: The stopping of a process

COAGULATION: In water treatment, the use of chemicals to make suspended solids gather or group together into small flocs. The clumping together of solids so they can more easily be settled out or filtered out of water.

COLORIMETRIC TESTING: A common method for testing how much of a substance is in the water is to run a colorimetric test. A colorimetric test is a test which forms a colour. The amount of the colour is then measured. In most tests the more colour formed, the more of the test substance there is in the water.

COMBUSTIBLE: A substance that is capable of igniting and burning.

CONDUIT: A conduit is a hollow tube, duct or pipe used for containing and protecting wires or pipes.

CORROSIVE: A liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact or is highly corrosive to steel.

#### [ CODE OF PRACTICE ON THE FLUORIDATION OF DRINKING WATER 2016 ]

DEMULCENT: Substance that protects mucus membranes and prevents or lowers irritation.

DOSE RATE: The dose delivered per litre of water.

FLUORIDATION: A water treatment involving the addition of fluoride to drinking water to help prevent dental caries.

FLUORIDE: A mineral that is effective in preventing and reversing the early signs of dental caries. Fluoride occurs naturally and contains the element fluorine.

FORUM ON FLUORIDATION: The Forum on Fluoridation was a panel of some 18 persons with a very wide range of appropriate knowledge, experience and responsibilities. This panel was given the task of examining all aspects of fluoridation and its role in Ireland, and making recommendations as to whether its use should be continued and, if so, in what form. Its report was issued in 2002 and can be accessed on the DoHC website (http://www.dohc.ie/publications/pdf/fluoridation\_forum.pdf)

HACCP: Hazard Analysis Critical Control Points. A system for risk management of a process, in wide scale use in the food industry.

HAZARDOUS WASTE: Waste which, because of its quantity, concentration or characteristics, poses a present or potential hazard to human health or the environment when improperly treated, stored, transported, dispersed of or otherwise managed.

HSE: Health Service Executive

HYDROFLUOSILICIC ACID: H2SiF6 (also known as hydrofluorosilicic acid; fluorosilicic acid; fluosilicic acid; hexafluorosilicic acid, HFSA): a chemical substance containing fluoride, used for fluoridation of drinking water.

INDELIBLE: Cannot be removed, washed away or erased.

INERT: Having little or no tendency to react chemically.

INTERLOCK: An interlock is a safety device used to help prevent a machine from harming its operator or damaging itself by stopping the machine when tripped.

IW: Irish Water

METHODOLOGY: A documented approach for performing activities in a coherent, consistent, accountable, and repeatable manner.

mg/l: milligrams per litre. It is the concentration of a substance expressed as its weight in a specified volume of liquid e.g. milligrams of fluoride per litre of water. It is equivalent to parts per million.

mg/m3: milligrams per cubic metre. It is the concentration of a substance expressed as its weight in a specified volume of a gas e.g. milligrams of fluoride per cubic metre of air.

NATURAL BACKGROUND FLUORIDE LEVELS: The concentration of fluoride (mg/L) that is present in the water source from naturally occurring fluoride sources.

OCCUPATIONAL EXPOSURE LIMIT: Describes an exposure standard for a chemical in workplace air, with reference to either an 8-hour reference period or a 15-minute reference period. The exposure limit values are based on time-weighted average (TWA) concentrations of airborne substances.

OCCUPATIONAL EXPOSURE LIMIT VALUE (OELV): An exposure level under which most people can work consistently for 8 hours a day, day after day, with no harmful effects.

PARTS PER MILLION (ppm): This is a way of expressing very dilute concentrations of substances. Just as per cent means out of a hundred, so parts per million or ppm means out of a million. Usually describes the concentration of something in water or soil. One ppm is equivalent to 1 milligram of something per litre of water (mg/l) or 1 milligram of something per kilogram soil (mg/kg).

pH: The pH of water is a scientific measurement that describes how acidic or alkaline (basic) a substance is, e.g. water with a pH of 7 is neutral. It is expressed on a scale from 0 to 14. A pH of less than 7 is acidic and greater than 7 is alkaline.

PRECIPITATION: Precipitation is the condensation of a solid from a solution during a chemical reaction. This occurs when the solution is supersaturated, whereupon the solid forms from the solute phase, and usually sinks to the bottom of the solution.

PRECISION: Is the closeness of agreement between the results obtained applying the method several times under prescribed conditions. The precision depends only on the distribution of random errors.

PUBLIC PIPED WATER SUPPLIES: A system that provides piped water to the public for human consumption.

PUNGENT: A sharp or stinging sensation of an odour.

SAFETY DATA SHEET: Printed material concerning a hazardous chemical, or Extremely Hazardous Substance, including its physical properties, hazards to personnel, fire and explosion potential, safe handling recommendations, health effects, firefighting techniques, reactivity, and proper disposal. It is prepared by chemical manufacturers, importers and employers for hazardous chemicals.

SCADA: Supervisory Control and Data Accquisition

#### [ CODE OF PRACTICE ON THE FLUORIDATION OF DRINKING WATER 2016 ]

SODA ASH: The common name for sodium carbonate. It is a white powder that is used to increase the pH of acidic (below pH 7.0) water.

SODIUM BICARBONATE: Also known as baking soda and bicarbonate of soda. It is a white powder used to balance pH level and alkalinity.

SOURCE WATER: Untreated water (ie, raw water) used to produce drinking water.

SPADNS: Colorimetric test reagent

STANDARD OPERATING PROCEDURE: Standard operating procedures are written documents that describe in detail, step-by-step, how a procedure should be done.

TELEMETRY INSTALLATION: An electronic device which transmits specific data (measurements) to a remote site.

TOXIC: Toxic means able to cause harmful health effects. Toxicity is the ability of a substance to cause harmful health effects. Descriptions of toxicity (eg low, moderate, severe, etc.) depend on the amount needed to cause an effect or the severity of the effect.

TURBULENCE: Irregular motion or swirling agitation of water, air, gas, etc.

VOLUMETRIC: Of or relating to measurement by volume; "volumetric testing".

WATERCOURSE: A definite channel with bed and banks within which concentrated water flows continuously, frequently or infrequently.

WATER TREATMENT PLANT: A plant where water is treated to make it fit for potable use.

#### FIRST AID IN THE EVENT OF CONTACT WITH HYDROFLUOSILICIC ACID

Report to the certified first-aider and Health and Safety Officer Refer to the Material Safety Data Sheet (MSDS) and seek medical attention.

The first-aid box should at all times contain adequate supplies of the following in specifically dealing with HFSA related incidents/accidents:

Calcium gluconate solution - Administer upon ingestion (or milk)
Sterile eyewash - Administer upon eye contact
Calcium gluconate gel - Administer to skin Effervescent
Calcium pills (400mg calcium per pill) - Administer dissolved in water upon inhalation.

#### IN CONTACT WITH EYES:

Immediately irrigate with water for at least 10 minutes and continue to do so until medical aid is obtained.

#### INGESTED:

Provided patient is conscious wash out mouth with water and give 5% Sodium Bicarbonate solution followed by a demulcent such as milk. Do NOT induce vomiting. Seek medical advice.

#### IN CONTACT WITH SKIN:

Remove contaminated clothing and wash affected area with copious amounts of water. Apply a dressing soaked in 20% Calcium Gluconate solution. Seek medical advice.

Refer to the Safety Data Sheet Section 7 First Aid Measures for the use of the above.

Always seek medical attention.

REPORTING OF INCIDENTS, INVOLVING SIGNIFICANT INJURIES, UNDE\R SAFETY, HEALTH & WELFARE AT WORK LEGISLATION

The following types of accidents must be reported to the Health and Safety Authority:

- The death of any employed or self-employed person, which was caused by an accident during the course of their work.
- An injury sustained in the course of their employment, which prevents any employed or self-employed person from performing the normal duties of their work for more than three calendar days, not including the date of the accident. Calendar days include Saturdays and Sundays. (For example, if an employee, who is injured on Wednesday, and does not normally work on Saturdays, Sundays and bank holidays, returns to work the following Monday, the accident is reportable).
- A death, or an injury that requires treatment by a registered medical practitioner, which does not occur while a person is at work, but is related to either a work activity or their place of work. Deaths or injuries caused by normal medical treatment (e.g. surgery or medication) do not need to be reported.
- A road traffic accident that meets the criteria (a) and (b) above, excluding an accident that occurs while a person is commuting either to or from work.
- A road traffic accident that meets the criteria (c) above as a result of construction work on or adjacent to a public road.
- Reporting can be done either online at http://www.hsa.ie or by filling out an IR1 Form.

Work place accidents must be reported promptly:

(a) Fatal or potentially fatal accidents must be reported immediately, by telephone in the first instance.(b) Non-fatal accidents should be reported as soon as practicable, in most cases within two weeks of the occurrence of the accident.

(c) Major accidents notifiable under the major accident hazards regulations must be reported immediately, by telephone in the first instance.

- In addition to these reporting requirements there is specific requirements to report under ADR: Activities involving loading, unloading, filling, carriage or unloading of Dangerous Goods which results in:
- Personal injury
  - Intensive medical treatment
  - Stay in hospital of one day
  - Inability to work for at least three consecutive days

- Loss of product (incl. imminent risk of it occurring)
  - 1,000L or more of transport category 3
  - 333L or more of transport category 2
- Material Damage/ environmental damage (damage exceeds €50,000)
- Involvement of the authorities (incl. emergency services)

PROCEDURE FOR DEALING WITH SPILLAGES OF HYDROFLUOSILICIC ACID

Operatives should be familiar with the Safety Data Sheet.

In the event of a spill or leak eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area) - although hydrofluosilicic acid is not combustible, it may decompose on heating to produce corrosive and/or toxic fumes. Runoff from fire control or dilution water may be corrosive and/ or toxic and cause pollution.

Do not touch damaged containers or spilled material unless wearing appropriate protective clothing and having received suitable training.

Stop the leak only if this can be done without risk. Prevent entry into waterways, sewers, basements or confined areas. In this regard it is essential that hydrofluosilicic acid spillage or leak containment facilities should not be constructed to drain to a watercourse. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. DO NOT LET WATER INSIDE CONTAINERS.

In the event of spillage from a delivery tanker, or leaking storage tank, please adhere to the following procedure.

PERSONAL PROTECTIVE CLOTHING MUST BE WORN, i.e. Full chemical resistant suit, PVC gloves, visor, helmet, wellington boots and gloves.

- In the event of a tanker spill, the driver should contact the suppliers of the chemical immediately (if this is not possible then the driver should ask a person present to contact them), treatment plant personnel should inform the Health and Safety Officer. All spills should be recorded on an accident/dangerous occurrence form.
- Place "DANGER" signs/cones in the vicinity of the spill.
- The area should be cleared of all personnel not involved in clean-up operations.
- Personnel engaged in the clean-up operation, should always position themselves upwind and be fully protected.
- Treat as weak acid

• Swill away with copious amounts of water from a hose pipe – always directing the water jet to the outside of the spillage taking extreme care not to let it go down any drains or watercourses. NEVER DIRECT THE WATER HOSE TO THE CENTRE OF THE SPILLAGE.

#### Small Spillage: Wash away with large quantities of water.

Wearing full protective clothing and working from the windward side wash down immediately with copious supply of water, directing the water jet to the outside of the spillage and carefully working towards the centre.

Large Spillage: If fumes are evolved wear respiratory protection. Bund large spillages with sand, earth etc. and pump away, neutralise with soda ash then dilute with water (spray) and flush away with large amounts of water after neutralisation. Inform the local water services authority if product has entered public drains or waterways.

#### Personal Precautions: Wear full protective clothing.

Neutralising Chemicals: Hydrated lime or soda ash.

#### UTILISE SPILL KIT

- Try to stop the flow of liquid product. Use earth or sand as boom if possible to try to contain liquid, gradually shovel this onto the spillage working from outside in.
- Neutralise contaminated boom for disposal with soda ash. Gradually shovel this onto the spillage working from outside in.
- In the event of a major spill contact IW / the Water Services Authority, the EPA, the Local Fisheries Board and the Health and Safety Authority (if required).

#### PERSONAL CONTAMINATION:

- Treat as weak acid.
- Wash out eyes and rinse skin with copious amounts of water
- Seek medical attention

Consult the ADR "Instructions in Writing" for further instructions. Do not leave the area unattended, if possible.

#### HAZARDOUS WASTE:

Any hazardous waste resulting from spillages (including sand and boom) or otherwise should be retained in appropriate waste storage containers that are clearly labelled as hazardous waste and have the correct chemical label on them. The waste should only be disposed of by a licensed hazardous waste contractor (refer to section 8.1.3) Details of the waste should be logged into the Hazardous Waste Logbook:

Drum No Type of waste (name of chemical) Quantity per ton EWC Code Company responsible for transport and disposal of the waste Destination of waste Waste Transfer Form - S.I. No. 324 of 2011, European Communities (Shipments of Hazardous Waste Exclusively within Ireland) Regulations 2011

# **APPENDIX 4**

SAMPLE DAILY CHECKLIST FOR FLUORIDATION PLANT

**PLANT PERIMETER AND BUILDINGS:** check integrity of fences, gates, door locks and bolts. Look for evidence of unauthorised entry to site or interference with facilities or equipment.

**BULK TANK AND BUND AREA:** check tank surfaces and bund for evidence of leaks. View tank contents level indicator – check for evidence of abnormal change in contents level. Assess need to re-order supply of acid.

**PIPEWORK**: examine all visible pipework, joints and valves for evidence of damage, leaks, or failure.

**DAY TANK AND BUND AREA**: assess level of tank contents for any abnormal change in level. Check for evidence of leaks. Carry out weighing of contents to calculate quantity of acid used since previous weighing. Ensure contents level, following refill, does not exceed maximum recommended capacity.

**DOSING PUMPS AND BUND AREA:** check for evidence of leaks or pump malfunction; check that pump is operating in 'external' mode. Ensure that back-up pump is not plugged in or operating simultaneously.

**MONITORING OF FLUORIDE CONCENTRATION:** where automated on-line monitoring is not in operation, carry out a colorimetric test in accordance with correct procedures and record result. Compare with theoretical concentration obtained from calculation of quantity of acid used (see 4 above).

*N.B.* please note that the above checklist does not purport to be a comprehensive assessment of the requirements of this code of practice but suggests those items that need to be assessed at least daily.

#### PROTOCOL FOR THE INDEPENDENT TESTING OF HFSA

#### 1. INTRODUCTION

This Protocol refers to the independent testing of Hydrofluosilicic Acid (HFSA) which is used for the fluoridation of water intended for human consumption (Chemicals used for treatment of water intended for human consumption, Hydrofluosilicic acid, I.S. EN 12175:2013).

The effectiveness of fluoridation in Ireland has been measured by comparing the dental health of children resident in fluoridated areas with those resident in nonfluoridated areas. Surveys have taken place on many occasions between 1984 and the most recent survey in 2006. All these studies have demonstrated that children in fluoridated areas have significantly better dental health. There continues to be overwhelming evidence that water fluoridation significantly benefits dental health and through this, benefits overall health.

The specification for HFSA is as follows:

- 10.9% by weight of HFSA, subject to a tolerance of ± 0.3%
- See limits for Heavy Metals in Table 1 below
- Shall contain no other soluble mineral or other organic substance in quantities capable of a deleterious or injurious effect upon health.

Each batch of HFSA 10.9% that is produced by the supplier has a representative sample analysed (not every batch is tested for Heavy Metals by the supplier, however it is carried out by the original manufacturer and the results are included on their Certificate of Analysis) and a Certificate of Analysis is produced stating the actual test results. This Certificate of Analysis must accompany each delivery of HFSA to the different water treatment plants (one tanker of HFSA may not necessarily deliver to a single plant). A sample is also taken from each tanker before it leaves the suppliers site and this is retained in the event of any queries on the quality of the material.

Methods for testing HFSA should be capable of serving their intended purpose: to quantify HFSA with adequate precision and accuracy.

Any laboratory carrying out Independent testing of HFSA according to this guidance must have appropriate quality systems in place and must be accredited to ISO17025.

Non-conforming results can sometimes be due to testing errors.

The sources of error that affect testing methods are:

- Sampling error the error due to the taking of subsamples
- Systematic error the error inherent in the method used
- Random laboratory error the error that is particular to a laboratory or analyst

In an attempt to reduce the effects of the last two errors to a minimum it is essential that laboratories use external reference in the form of appropriate use of reference materials and take part in recognised external quality assessment schemes.

In addition, a quality assurance programme must be in place and documented in the quality manual used.

#### 2. PURPOSE

The purpose of this protocol is to clearly identify the guidelines required for the independent testing of hydrofluosilicic acid (HFSA), to meet the requirements of the National Fluoridation Programme.

#### 3. SCOPE

This document describes the procedure for the Independent Testing of HFSA. A protocol gives detailed instructions, including the collection of samples, and recommends the frequency of sampling. The protocol applies to all personnel involved in the independent testing and subsequent reporting of results of HFSA.

#### 4. RESPONSIBILITY

It is the responsibility of the Health Service Executive to ensure that the independent testing of HFSA is carried out.

It is the responsibility of the Health Service Executive to ensure that timely reporting of the results from the independent testing of the HFSA is carried out.

It is the responsibility of the supplier to facilitate the awarding authority in the independent testing of samples for analysis of the HFSA and all its concentrations, independently of the supplier.

#### 5. PROCEDURE

**5.0** Approximately 300 tankers are delivered to the various water treatment plants around the country. Thirty grab samples per annum should be taken at random for independent testing. This sampling frequency may be reduced for a given year if all sample results for the supplier for the previous year are satisfactory. In such circumstances the minimum frequency of sampling should be not less than 12 grab samples per annum.

At random locations (a) from the supplier's tanker before it leaves for delivery to treatment plants (b) from an appropriate location at the water treatment plant.

5.1 A schedule should be drawn up on an annual basis highlighting when and where the random sampling for independent testing is carried out to ensure that sampling is representative and at the correct frequency.

5.2 The container to be used for sampling must be of suitable acid resistant material (not glass), clean, free of contamination and should have a tamper evident cap on it. The sample container should be labelled and have the following information clearly visible on it:

Name of sample: i.e. HFSA 10.9%

Sample number\*: Date

Sample taken by:

Name of treatment plant:

#### \* This sample number should be a unique identifier so that duplication is not possible.

#### [ CODE OF PRACTICE ON THE FLUORIDATION OF DRINKING WATER 2016 ]

5.3 Personnel sampling the HFSA must ensure that they are compliant with The Safety, Health and Welfare Act 2005 by using the correct personnel protective equipment (PPE) including safety goggles, rubber gloves, protective clothing. (Refer to Code of Practice on fluoridation of public water supplies). The sample must be collected in a safe manner. If it is not possible to obtain the sample safely, personnel should not proceed with the task and must report to the person responsible for Health and Safety.

5.4 A sample of 200ml should be taken for sampling and testing. Before sampling approximately 200ml should be run off into a clean and contamination free container to ensure a representative sample is obtained. The run-off can then be put back into the storage tank, thereby reducing the amount of waste generated.

5.5 The labelled sample is to be then sent in a tamper evident container to the contract laboratory concerned for testing.

Transport of the sample must comply with the European Communities Carriage of Dangerous Goods by Road and Use of Transportable Pressure Equipment Regulations 2011 (S.I. no. 349 of 2011) as amended by S.I. no. 238 of 2013, or subsequent Regulations. These regulations apply to the carriage, in tanks, in bulk and in packages, of dangerous goods by road; including the packing, loading, filling and unloading of the dangerous goods in relation to their carriage.

The Regulations impose duties on the various participants associated with the carriage of the dangerous goods. They contain requirements for the vehicles, tanks, tank containers, receptacles and packages containing the dangerous goods during their carriage. They require that the drivers and others, involved in the carriage of the dangerous goods by road (including their packing/loading/filling/transport/unloading) be adequately trained and, in the case of drivers, hold certificates of such.

5.6 All of the sample details (as outlined in 5.2) and the integrity of the tamper evident container must be logged into the relevant Laboratory Testing Logbook or Laboratory Information Management System (LIMS System), to be maintained by the Independent sampling body.

5.7 The method of testing that should be adopted is based on the performance characteristics that are required to be met for the measurement of fluoride. (See Note 1)

Methods already capable of meeting performance characteristics as per the Drinking Water Regulations can be suitably adapted for the determination of fluoride and heavy metals in HFSA Samples.

European Standard I.S. EN 12175:2013

## **TABLE 1: PARAMETERS FOR HEAVY METALS\***

PARAMETER	LIMIT mg/kg HFSA (AT 100% ACTIVE INGREDIENT)
Antimony (Sb) max.	80
Arsenic (As) max.	400
Cadmium (Cd) max.	40
Chromium (Cr ) max.	400
Lead (Pb) max.	400
Mercury (Hg) max.	10
Nickel (Ni) max.	400
Selenium (Se) max.	80

# Note: Other chemical parameters and indicator parameters – as listed in EU Directive 98/83/EEC (see [1]- are not relevant in hydrofluosilicic acid because the raw materials used in the manufacturing process are free of them.

\* specification was previously referenced as  $\leq 0.06\%$  by weight "heavy metals" expressed as lead (Pb) in the tender document for HFSA and is no longer applicable.

5.8 If a non-compliant result is obtained by the laboratory, the sample is to be retested. If a second non-compliant result is obtained, then re-sampling from the treatment plant involved is to be carried out.

#### 6.0 ACTION TO BE TAKEN IN THE EVENT OF A NON-COMPLIANCE

6.1 If the result is discovered at the supplier's premises it may not be necessary to shut off any fluoridation plant as the fluoride may not have been delivered to any plants.

6.2 If the fluoride has been delivered to treatment plants it will be necessary to trace back the delivery to the original batch. Even though one tanker may be non-compliant it may have been caused by the supplier having the wrong strength batch at the supplier's premises and thus several deliveries could have gone out in several tankers to several plants.

In the case of a non-compliant result being determined, if the test finds that the sample does not meet the specification, and if it is the case that the non-compliance is related to the batch, then all of the plants to which the non-compliant batch was delivered would need to be informed and fluoridation should be suspended.

There is no justification for suspending fluoridation where the HFSA is under-strength as it will still give a dental health benefit while complying fully with drinking water regulations fluoride limit values. If HFSA is over strength but not at a level that would result in over fluoridation the supplier should be contacted.

Once the actual strength of the non-compliant fluoride is determined some plants may be able to adjust their dosing regime to allow for this and can continue fluoridation. Where this cannot be reliably done, fluoridation should be suspended pending removal of the non-compliant batch from the treatment plant.

# The Health Service Executive, IW and the Water Services Authority concerned are to be informed immediately and at all times of any non-conformances. \*

At a dosing rate giving a final fluoride concentration in the treated water of 0.7mg/l (i.e. at the midpoint of the statutory range) and using hydrofluosilicic acid of correct concentration (i.e. 10.9%), the same dosing rate, would only result in a final fluoride concentration greater than 0.8 mg/l (i.e. exceeding the statutory range) if the hydrofluosilicic acid concentration exceeded 12.4% (12.456 % to be exact). This has been calculated as follows: divide 0.8 by 0.7 and multiply the answer by 10.9.

#### 6. REFERENCES

6.0 User-Guide for supply and delivery of chemicals used for treatment of water intended for human consumption, Hydrofluosilicic acid - Health Service Executive, Shared Services-Eastern Region

6.1 The Safety, Health and Welfare at Work Act 2005 http://www.irishstatutebook.ie/2005/en/act/pub/0010/

6.2 Protocol on comparison of methods for drinking water bacteriology – cultural techniques – January 2000. Drinking Water Inspectorate (DWI)

6.3 Chemicals used for treatment of water intended for human consumption, Hydrofluosilicic acid, I.S. EN 12175:2013

6.4 Correspondence on Analytical Methods for fluoride in water – Dr Michael O'Sullivan, Public Analyst Laboratory Dublin.

6.5 European Communities Carriage of Dangerous Goods by Road and Use of Transportable Pressure Equipment Regulations 2011 (S.I. no. 349 of 2011) as amended by S.I. no. 238 of 2013, or subsequent Regulations.

6.6 McLoughlin J., Clarkson J., Connolly F., Hargaden J. An Evaluation of the Delivery and Monitoring of Water Fluoridation in Ireland. A report conducted by the Department of Public and Child Dental Health, Dublin Dental School & Hospital. 2005. Dublin: Department of Health and Children.

# NOTE 1

#### RE: ANALYTICAL METHODS FOR FLUORIDE IN WATER

There are a number of methods for measuring fluoride in drinking water. These include ion-selective electrode, ion chromatography, and colorimetric methods.

It is not possible or appropriate to recommend a 'standard method' for the measurement of fluoride in drinking water. The approach that should be adopted is based on the performance characteristics that are required to be met for the measurement of fluoride. Appropriate performance characteristics are those specified in European Communities (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014) which came into force on the 7th March 2014. The Performance Characteristics stipulated for fluoride are:

TRUENESS (ACCURACY) % OF PARAMETRIC VALUE	PARECISION % OF PARAMETRIC VALUE	LIMIT OF DETECTION (LOD) % OF PARAMETRIC VALUE
10	10	10

This means that the current fluoride EU Parametric Value of o.8 mg/l ( $800 \mu g/l$ ) would require Trueness, Precision and LOD of 0.08 mg/l ( $80 \mu g/l$ ). Both the ion-selective electrode and ion chromatography techniques can achieve this. These methods can achieve commensurate Performance Characteristics for the current fluoride levels under the Fluoridation Act and any future revised fluoride level, down to about 0.5 mg/l.

# **CODE OF PRACTICE ON THE FLUORIDATION OF DRINKING WATER 2016**

Appendix 6 USEPA SPADNS Method

Please note that this is a direct reproduction of an American Method so some spellings are therefore an American version.

# Fluoride

#### USEPA SPADNS Method<sup>1</sup>

#### 0.02 to 2.00 mg/L F<sup>-</sup>

# Reagent Solution or AccuVac<sup>®</sup> Ampuls

DOC316.53.01041

Method 8029

**Scope and application:** For water, wastewater and seawater; USEPA accepted for reporting for drinking and wastewater analyses (distillation required).<sup>2</sup>

<sup>1</sup> Adapted from Standard Methods for the Examination of Water and Wastewater, 4500-F B & D.

<sup>2</sup> Procedure is equivalent to USEPA method 340.1 for drinking water and wastewater.

# Test preparation

#### Instrument-specific table

The tables in this section show all of the instruments that have the program for this test. Table 1 shows sample cell and orientation requirements for reagent addition tests, such as powder pillow or bulk reagent tests. Table 2 shows sample cell and adapter requirements for AccuVac Ampul tests.

To use either table, select an instrument, then read across to find the corresponding information for this test.

Instrument	Sample cell orientation	Sample cell
DR 6000	The fill line is to the right.	2495402
DR 3800		
DR 2800		<u>10 mL</u>
DR 2700		
DR 5000	The fill line is toward the user.	
DR 3900		
DR 900	The fill line is toward the user.	2401906

#### Table 1 Instrument-specific information for reagent solution

#### Table 2 Instrument-specific information for AccuVac Ampuls

Instrument	Adapter
DR 6000	_
DR 5000	
DR 900	
DR 3900	LZV846 (A)
DR 3800	LZV584 (C)
DR 2800	
DR 2700	

#### **Before starting**

Install the instrument cap on the DR 900 cell holder before ZERO or READ is pushed.

The sample and deionized water must be at the same temperature ( $\pm 1$  °C). Temperature adjustments can be made before or after the reagent addition.

Make sure that the sample cells are clean and dry before the test.

Measure the volume of the reagent accurately. Use a pipet if possible.

The reagent that is used in this test is corrosive and toxic. Use protection for eyes and skin and be prepared to flush any spills with running water.

The SPADNS Reagent contains sodium arsenite. The reacted solutions must be disposed of according to local, state and federal regulations.

Minor variations between lots of reagent become measurable above 1.5 mg/L. While results above 1.5 mg/L are usable for most purposes, for the best accuracy dilute the sample to a lower concentration.

Do not use the Pour-Thru Cell or sipper module (for applicable instruments) with this test.

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used and use any recommended personal protective equipment.

Dispose of reacted solutions according to local, state and federal regulations. Use the Safety Data Sheets for disposal information for unused reagents. Consult the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

#### Items to collect

#### **Reagent solution**

Description	Quantity
SPADNS Reagent Solution	4 mL
Deionized water	10 mL
Pipet, volumetric, 2-mL	1
Pipet, volumetric, 10-mL	1
Pipet filler bulb	1
Sample cells (For information about sample cells, adapters or light shields, refer to Instrument-specific table PPAV.)	2
Thermometer, -10 to 110 °C	1

Refer to Consumables and replacement items on page 55 for reorder information.

#### AccuVac Ampuls

Description	Quantity
SPADNS Fluoride Reagent AccuVac <sup>®</sup> Ampuls	2
Deionized water	40 mL
Beaker, 50-mL	1
Stoppers for 18 mm tubes and AccuVac Ampuls	2

Refer to Consumables and replacement items on page 6 for reorder information.

#### Sample collection and storage

- Collect samples in clean glass or plastic bottles.
- Samples can be kept for up to 28 days.
- Let the sample temperature increase to room temperature before analysis.

#### **SPADNS** reagent solution method



1. Start program 190 Fluoride. For information about sample cells, adapters or light shields, refer to Instrumentspecific table PPAV.

**Note:** Although the program name may vary between instruments, the program number does not change.



2. Prepare the blank: Use a pipet to add 10.0 mL of deionized water to a sample cell.



**3. Prepare the sample:** Use a pipet to add 10.0 mL of sample to a sample cell.



**4.** Use a pipet to add 2.0 mL of SPADNS Reagent Solution into each sample cell.



5. Swirl to mix.



**6.** Start the instrument timer. A 1-minute reaction time starts.



**7.** When the timer expires, clean the blank.



**8.** Insert the blank into the cell holder.



**9.** Push **ZERO**. The display shows 0.00 mg/L F<sup>-</sup>.



**10.** Clean the prepared sample.



**11.** Insert the prepared sample into the cell holder.



**12.** Push **READ**. Results show in mg/L F<sup>-</sup>.

#### AccuVac Ampul procedure



1. Start program 195 Fluoride AV. For information about sample cells, adapters or light shields, refer to Instrumentspecific table PPAV.

**Note:** Although the program name may vary between instruments, the program number does not change.



2. Prepare the blank: Pour at least 40 mL of deionized water in a 50-mL beaker. Fill one SPADNS Fluoride Reagent AccuVac Ampul with deionized water. Keep the tip immersed while the Ampul fills completely.



**3. Prepare the sample:** Collect at least 40 mL of sample in a 50-mL beaker. Fill the second SPADNS Fluoride Reagent AccuVac Ampul with sample. Keep the tip immersed while the Ampul fills completely.



**4.** Quickly invert the Ampuls several times to mix.

Zero



**5.** Start the instrument timer. A 1-minute reaction time starts.



**9.** Clean the AccuVac Ampul.



**6.** When the timer expires, clean the blank AccuVac Ampul.

10. Insert the prepared

the cell holder.

sample AccuVac Ampul into



**7.** Insert the blank AccuVac Ampul into the cell holder.



cuVac 8. Push ZERO. The display der. shows 0.00 mg/L F<sup>−</sup>.

**11.** Push **READ**. Results show in mg/L F<sup>-</sup>.

#### Interferences

This test is sensitive to small amounts of contamination. Glassware must be very clean (acid rinse before each use). Repeat the test with the same glassware to make sure that the results are accurate.

Interfering substance	Interference level
Alkalinity (as CaCO <sub>3</sub> )	At 5000 mg/L, it causes a –0.1 mg/L F <sup>–</sup> error.
Aluminum	At 0.1 mg/L, it causes a $-0.1$ mg/L F <sup>-</sup> error. To find whether there is an aluminum interference, read the concentration 1 minute after reagent addition, then again after 15 minutes. An appreciable increase in concentration suggests aluminum interference. To remove the effect of up to 3.0 mg/L aluminum, wait 2 hours, then take the final reading.
Chloride	At 7000 mg/L, it causes a +0.1 mg/L F <sup>-</sup> error.
Chlorine	SPADNS Reagent contains enough arsenite to remove up to 5 mg/L chlorine. For higher chlorine levels, add one drop of Sodium Arsenite Solution, 5.0 g/L, to 25 mL of sample to remove each additional 2 mg/L of Chlorine.
Iron, ferric	At 10 mg/L, it causes a –0.1 mg/L F <sup>–</sup> error.
Phosphate, ortho	At 16 mg/L, it causes a +0.1 mg/L F <sup>-</sup> error.
Sodium hexametaphosphate	At 1.0 mg/L, it causes a +0.1 mg/L F <sup>-</sup> error.
Sulfate	At 200 mg/L, it causes a +0.1 mg/L F <sup>-</sup> error.

#### Distillation

To eliminate most interferences, distill the sample, then use the distilled sample in the test procedure.

#### Prerequisite—prepare the distillation solution:

- 1. Measure 60 mL of deionized water into a 250-mL, glass Erlenmeyer flask.
- 2. With constant stirring, add 120 mL of concentrated sulfuric acid. Caution: The mixture will become very hot. Put the flask in an ice bath to decrease the temperature of the solution.

#### **Distillation procedure:**

- Set up the distillation apparatus for general purpose distillation. Refer to the Distillation Apparatus manual for proper assembly. Use a 125-mL Erlenmeyer flask to collect the distillate.
- 2. Turn on the water and maintain a steady flow through the condenser.
- **3.** Use a 100-mL graduated cylinder to add 100 mL of sample into the distillation flask. Add a magnetic stir bar and 5 glass beads.
- 4. Turn the stirrer power switch on. Turn the stir control to 5.
- 5. Use a 250-mL graduated cylinder to carefully add 150 mL of distillation solution into the flask.

**Note:** For samples with large amounts of chloride, add 5 mg of silver sulfate to the sample for every mg/L of chloride in the sample.

- **6.** With the thermometer inserted, turn the heat control to 10. The yellow pilot lamp is an indication that the heater is on.
- 7. When the temperature is 180 °C (356 °F) or when 100 mL of distillate has been collected, turn the still off (takes about 1 hour).
- **8.** Dilute the distillate to a volume of 100 mL, if necessary. Use the diluted distillate in the test procedure.

#### Pollution prevention and waste management

Reacted samples contain sodium arsenite and must be disposed of as a hazardous waste. Dispose of reacted solutions according to local, state and federal regulations.

#### Accuracy check

#### Standard solution method

Use the standard solution method to validate the test procedure, reagents and instrument.

Items to collect:

- Standard solution within the test range
- 1. Use the test procedure to measure the concentration of the standard solution.
- 2. Compare the expected result to the actual result.

**Note:** The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.

#### Method performance

The method performance data that follows was derived from laboratory tests that were measured on a spectrophotometer during ideal test conditions. Users may get different results under different test conditions.

Program	Standard	Precision (95% Confidence Interval)	Sensitivity Concentration change per 0.010 Abs change
190	1.00 mg/L F <sup>-</sup>	0.97–1.03 mg/L F <sup>–</sup>	0.024 mg/L F <sup>−</sup>
195	1.00 mg/L F <sup>-</sup>	0.92–1.08 mg/L F <sup>–</sup>	0.03 mg/L F <sup>_</sup>

#### Summary of method

The SPADNS Method for fluoride determination involves the reaction of fluoride with a red zirconium-dye solution. The fluoride combines with part of the zirconium to form a colorless complex, thus bleaching the red color in an amount proportional to the fluoride concentration. This method is accepted by the EPA for NPDES and NPDWR reporting purposes when the samples have been distilled. Seawater and wastewater samples require distillation. The measurement wavelength is 580 nm for spectrophotometers or 610 nm for colorimeters.

#### **Consumables and replacement items**

#### **Required reagents**

Description	Quantity/test	Unit	ltem no.
SPADNS Reagent Solution	4 mL	500 mL	44449
OR			
SPADNS Fluoride Reagent AccuVac® Ampul	2	25/pkg	2506025
Water, deionized	varies	4 L	27256

#### **Required apparatus (solution)**

Description	Quantity/test	Unit	Item no.
Pipet filler, safety bulb	1	each	1465100
Pipet, volumetric, Class A, 2.00-mL	1	each	1451536
Pipet, volumetric, Class A, 10.00-mL	1	each	1451538
Sample cell, 10 mL square, matched pair	2	2/pkg	2495402
Thermometer, -10 to 110 °C	1	each	187701

#### Required apparatus (AccuVac)

Description	Quantity/test	Unit	Item no.
Beaker, 50-mL	1	each	50041H
Sample cell, 10 mL round, 25 x 54 mm	1	each	2122800
Sample cell, 10 mL round, 25 x 60 mm	1	6/pkg	2427606

#### **Recommended standards**

Description	Unit	ltem no.
Fluoride Standard Solution, 0.2-mg/L F-	500 mL	40502
Fluoride Standard Solution, 0.5-mg/L F <sup>-</sup>	500 mL	40505
Fluoride Standard Solution, 0.8-mg/L F <sup>-</sup>	500 mL	40508
Fluoride Standard Solution, 1.0-mg/L F <sup>-</sup>	1000 mL	29153
Fluoride Standard Solution, 1.0-mg/L F <sup>-</sup>	500 mL	29149
Fluoride Standard Solution, 1.2-mg/L F <sup>-</sup>	500 mL	40512
Fluoride Standard Solution, 1.5-mg/L F <sup>-</sup>	500 mL	40515
Fluoride Standard Solution, 2.0-mg/L F <sup>-</sup>	500 mL	40520
Fluoride Standard Solution, 100-mg/L F <sup>-</sup>	500 mL	23249
Drinking Water Standard, Mixed Parameter, Inorganic for F <sup>-</sup> , NO <sub>3</sub> , PO <sub>4</sub> , SO <sub>4</sub>	500 mL	2833049

#### Distillation reagents and apparatus

Description	Unit	ltem no.
Cylinder, graduated, 100-mL	each	50842
Cylinder, graduated, 250-mL	each	50846
Distillation heater and support for 2265300, 115 VAC, 60 Hz	each	2274400
OR		
Distillation heater and support for 2265300, 230 VAC, 50 Hz	each	2274402
AND		
Distillation apparatus set, general purpose	each	2265300
Flask, Erlenmeyer, 125-mL	each	2089743
Glass beads	100/pkg	259600
Stir bar, magnetic	each	1076416
Sulfuric Acid, ACS	500 mL	97949

#### **Optional reagents and apparatus**

Description	Unit	ltem no.
Silver Sulfate	113 g	33414
Sodium Arsenite, 5 g/L	100 mL	104732
AccuVac <sup>®</sup> Snapper	each	2405200
Wipes, disposable	280/pkg	2097000

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#### This list is for reference purposes only, it is not a comprehensive appendix.

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# CODE OF PRACTICE ON THE FLUORIDATION OF DRINKING WATER

PREPARED BY THE QA SUB-COMMITTEE, IRISH EXPERT BODY ON FLUORIDES & HEALTH AND APPROVED BY THE IRISH EXPERT BODY ON FLUORIDES AND HEALTH

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ISBN: 978-0-9551231-4-6 The Irish Expert Body of Fluorides and Health An Corpán Oilte Éireannach um Fluairídí agus Sláinte PO Box 12343, Dublin 2, Ireland T: +353 1 6728870 F: +353 1 6728801 http://www.fluoridesandhealth.ie [ CODE OF PRACTICE ON THE FLUORIDATION OF DRINKING WATER 2016 ]