water
NEW ZEALAND
The New Zealand Water & Wastes Association Wai ora Aotearoa

WATER NEW ZEALAND
Code of Practice

Fluoridation of Drinking-Water Supplies in New Zealand

First Edition - December 2014

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Contents

YouTube A video introduction to this guide, along with a video overview of this code of practice, are available on our website www.waternz.org.nz.

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Foreword

Water fluoridation is the adjustment of the natural content of fluoride in drinking-water to a level that helps protect teeth against dental decay. Tooth decay is a largely preventable disease that affects both children and adults. It can cause considerable pain and suffering as well as a significant cost, which is unaffordable for some low income earners. Fluoride in drinking-water acts like a constant repair kit that neutralises the effect of acids that cause decay and helps to repair damage before it becomes permanent. Water fluoridation is the most effective and socially equitable way to give everybody access to the caries-preventive effects of fluoride regardless of age, income or education level.

In New Zealand, the decision to adjust the level of fluoride in water supplies is held by drinking-water suppliers (Local Authorities and other owners).

The *Code of practice for fluoridation of drinking-water supplies in New Zealand* (this Code) specifies good practice for the design and operation of water fluoridation plants to ensure the safe and effective addition of fluoride to drinking-water supplies. Although compliance with this Code is not a legal requirement, water suppliers are encouraged to comply with the Code to ensure the safety of their consumers. Compliance with the Code is also a way to provide increased public confidence.

The Ministry of Health and Water New Zealand would like to acknowledge the assistance of the Victorian Department of Health, as well as the important contributions from a wide range of water suppliers and industry stakeholders who assisted in this process. Both the Ministry of Health and Water New Zealand are committed to working with the water industry to ensure the safe and effective addition of fluoride to drinking-water supplies.

This Code is endorsed by the Ministry of Health as representing good practice for the addition of fluoride to drinking-water for the promotion of dental health. Suppliers that are designing new fluoridation plants are encouraged to comply. Suppliers with existing plants should consider the Code and plan to upgrade so that compliance is reached in the future.

Dr Don Mackie
Chief Medical Officer
Ministry of Health

1 Introduction

There is no legislation in New Zealand that requires the addition of fluoride to a water supply. Fluoridation is undertaken by drinking-water suppliers at their discretion. In the Drinking Water Standards for New Zealand 2005 (revised 2008) the Ministry of Health recommends that the fluoride content in New Zealand drinking water should be in the range of 0.7 to 1.0 mg/L for oral health reasons. The Code of practice for fluoridation of drinking-water supplies in New Zealand (this Code) specifies good practice for the safe design and effective operation of a fluoridation plant.

Safe and effective fluoridation of drinking-water supplies requires the adoption of a preventive risk management approach in the design and operation of fluoridation plants. Preventive risk management systems are the most effective way to assure the safe and effective addition of fluoride into a drinking-water supply. These systems underpin the approach taken in Water Safety Plans.

1.1 Objective

The overall objective of this Code is to provide guidelines for safe and effective addition of fluoride into a drinking-water supply.

This objective is achieved by specifying:

- Optimum fluoride levels for drinking-water supplies as defined by the Ministry of Health and the design control limits for fluoridation plants.
- Minimum requirements for the safe and effective addition of fluoride chemicals to drinking-water supplies, covering the design and operation of a fluoridation plant.
- Monitoring and reporting requirements for fluoridation.

1.2 Scope

This Code should apply to all new and upgraded water fluoridation plants after 1 January 2015. After 1 January 2020 the Code will also apply to existing fluoridation plants that have not been upgraded.

The Code describes:

- The regulatory framework (Section 2).
- Safety in design (Section 3).
- Requirements for the design and control of fluoridation facilities (Section 4).
- Requirements for plant operation including monitoring, training of personnel, occupational health and safety, security and environmental protection (Section 5).

1.3 Terminology

1.3.1	*Code of practice for fluoridation of drinking-water supplies in New Zealand:*	This code
1.3.2	*Drinking-water Assessor (DWA):*	A person appointed under the Health Act 1956 (the Act) to assess drinking-water supplies.
1.3.3	*Drinking-water Supplier:*	The Act defines a drinking-water supplier as a person who supplies drinking water to people in New Zealand or overseas from a drinking water supply, and: a) Includes that person's employees, agents, lessees, and subcontractors while carrying out duties in respect of that drinking water supply; and b) Includes (without limitation) i. A networked supplier; and ii. A water carrier; and iii. Every person who operates a designated port or airport; and iv. A bulk supplier; and v. Any person or class of person declared by regulations made under section 69ZZY to be a drinking water supplier for the purposes of this Part (a prescribed supplier); but c) Does not include vi. A temporary drinking water supplier; or vii. A self-supplier; or viii. Any person or class of person declared by regulations made under section 69ZZY not to be a drinking water supplier for the purposes of this Part.
1.3.4	*Drinking-water Standards for New Zealand 2005 (revised 2008):*	The DWSNZ
1.3.5	*Fluoride concentration:*	The fluoride concentration refers to the total amount of fluoride present regardless of its form and is expressed in milligrams per litre (mg/L) (Note: 1 mg/L = 1 g/m^3 = 1 ppm).
1.3.6	*Fluoridation plant:*	The building and equipment required for fluoridation of drinking-water, including chemical storage and unloading areas, dosing and control equipment, safety equipment and other fixtures used for, or associated with, the purpose of fluoridation.
1.3.7	*Guidelines for Drinking-water Quality Management for New Zealand:*	Guidelines to help water suppliers to comply with the DWSNZ.
1.3.8	*Hazardous Substances and New Organisms Act 1996:*	HSNO
1.3.9	*Health Act 1956:*	The Act that aims to protect public health by improving the quality of drinking-water provided to communities.
1.3.10	*Independent Checks:*	A control system that is entirely independent of another that is used to prevent the overdosing of fluoride.
1.3.11	*Maximum Acceptable Value:*	'MAV' as defined by the DWSNZ.
1.3.12	*'Must' and 'should':*	The word **'must'** identifies a mandatory requirement for compliance with this Code. The word **'should'** refers to practices that are advised or recommended but are not mandatory for compliance with this Code.

2 Regulatory Framework

2.1 Legislation

2.1.1 Acts

The requirements for the supply of drinking-water are set out in the Local Government Act 2002 (for Local Authorities) and the Health Act 1956. Specifically, under Section 23 of the Health Act, territorial authorities have a duty to improve, promote and protect public health; and under Section 25, to provide sanitary works including drinking-water supplies when directed by the Minister.

The Health Act 1956 was amended by the Health (Drinking Water) Amendment Act in October 2007 and aims to protect public health by improving the quality of drinking-water provided to communities. The Act requires drinking-water suppliers to:

- Take all practicable steps to ensure they provide an adequate supply of drinking-water that complies with the Drinking-water Standards for New Zealand
- Prepare and implement Water Safety Plans (see Section 2.1.3)

2.1.2 Drinking-water Standards for New Zealand

The Drinking-water Standards for New Zealand 2005 (revised 2008) (DWSNZ) specify water quality standards and compliance criteria for microbiological, chemical and radiological contaminants (determinands) in drinking-water.

The DWSNZ set a Maximum Acceptable Value (MAV) of 1.5 mg/L for fluoride. The MAV of a chemical is the concentration of that chemical which does not result in any significant risk to the health of a 70 kg person over a lifetime of consumption of two litres of the water a day. The 1.5 mg/L MAV for fluoride is based on the latest World Health Organisation (WHO) Guidelines.

Fluoride is classified as a Priority 2a determinand in the DWSNZ. As such fluoridated drinking-water supplies must be sampled at least weekly to monitor fluoride levels in the water leaving the treatment plant.

2.1.3 Water Safety Plans

A Water Safety Plan requires a drinking-water supplier to consider the potential risks to the water supply and identify ways to manage these risks, and is therefore prepared for any problems that may arise. Large (more than 10,000 people), medium (5001 to 10,000 people) and minor (501 to 5,000 people) drinking-water suppliers are required under the Act to prepare and implement approved Water Safety Plans. Small drinking-water suppliers need to implement a Water Safety Plan at the request of a Medical Officer of Health or to demonstrate they are taking all practicable steps to comply with the DWSNZ.

Drinking-water suppliers are required to start implementing their Water Safety Plans within one month of approval.

2.1.4 This Code

This Code describes good practice for drinking-water fluoridation. There is no legislation in New Zealand that requires the addition of fluoride to a water supply. Fluoridation is undertaken at the discretion of a drinking-water supplier. While there is no legal requirement to comply with this Code, it consolidates good practice from the New Zealand water industry. It therefore represents an industry-endorsed Code and, if complied with, a means of documenting in the Water Safety Plan that the risks associated with fluoridation in the supplier's water supply plant have been satisfactorily mitigated.

The Code has been written to assist water-suppliers in designing a new drinking-water fluoridation system, or upgrading an existing system to ensure the safety of its consumers. This Code describes information that is suggested for inclusion in a drinking-water supplier's Water Safety Plan, but inclusion is not required for Water Safety Plan approval by the DWA.

2.1.5 Other Legislation

Other legislative requirements of relevance to the management of a water fluoridation scheme include:

- *Hazardous Substances and New Organisms (HSNO) Act 1996*
- *Health and Safety at Work Act 2014*[1]
- *Building Act 2004*
- *NZ Building Code*
- *Land Transport Act 1998*
- *Land Transport Rule* (Dangerous Goods 2005) *45001*
- *Resource Management Act 1991*

2.2 Roles and Responsibilities

2.2.1 Ministry of Health

The function of the Ministry of Health is improving, promoting, and protecting public health. Its role is to encourage drinking-water suppliers to consider the use of fluoride for improvement of consumers' teeth, as well as to ensure that fluoride is added to drinking-water in a safe and effective way. The Ministry of Health's position is that the addition of fluoride to drinking-water is a safe, effective and affordable way to prevent and reduce tooth decay across the whole population. If subsidy for capital works to install fluoridation is available from the Ministry of Health, compliance with this Code among other factors would be assessed.

2.2.2 Drinking-water Supplier

For new and upgraded fluoridation plants, the drinking-water supplier should design, construct and operate the fluoridation plant in accordance with this Code.

Prior to the construction of a fluoridation plant, the drinking-water supplier should have the design peer-reviewed against this Code. Evidence of the peer review of the design should be provided to the DWA to demonstrate that the plant will operate in a safe and effective manner.

[1] As at 31 October 2014 it is the Government's intention that the Health and Safety Reform Bill will be passed in 2014, with the new Act coming into force from 1 April 2015. It will replace the Health and Safety in Employment Act (1992).

When a drinking-water supplier is implementing a new or upgraded fluoridation plant, the DWA needs to be advised at the design phase, the construction phase, and immediately prior to introducing fluoride to the supply.

The drinking-water supplier is responsible for ensuring that the design, installation and operation of the fluoridation plant, and the storage and handling of chemicals, are in accordance with all the relevant legislative requirements. Specifically, the drinking-water supplier must ensure that the water fluoridation plant is incorporated into the Water Safety Plan for a drinking-water supply. Future intent to add fluoride should also be indicated in the Water Safety Plan. In relation to transport of chemicals, the drinking-water supplier is responsible for engaging contractors who comply with relevant legislative requirements. Shipping of the chemicals, unloading and storage should be in accordance with the Water New Zealand, Good Practice Guide: *Supply of Fluoride for Use in Water Treatment*.

3 Safety in Design

3.1 Approach

The Safety in Design process involves the application of a risk management framework early in the design process to eliminate or minimise the risk to public health and the environment and to ensure occupational health and safety throughout the life of the fluoridation plant. It encompasses all phases of the plant design including facilities, hardware, systems, equipment, products, tooling, materials, energy controls, layout and configuration. From April 2015, a new Health and Safety at Work Act will be introduced and it will include Safety in Design requirements[2].

In the context of water fluoridation, Safety in Design encompasses:

- Drinking-water safety for consumers
- Occupational health and safety
- Environmental safety
- Asset safety

A safe design basis, together with a formal safety management system and safety practices, procedures, and training, is critical for providing the level of confidence required.

3.2 Risk Assessment

Drinking water suppliers that are fluoridating or are planning on installing new plant to fluoridate must carry out and document a site-specific risk assessment covering all aspects of safety and environmental risk associated with the design and operation of the fluoridation plant. Where risks are identified, appropriate control measures (based on the hierarchy of controls) must be implemented. The preventive risk management system must include the development of considered and controlled responses to incidents or emergencies that can compromise the safety of fluoridating a drinking-water supply, worker safety or the environment.

Based on the hierarchy of controls, hazards should be eliminated wherever practicable, followed by minimising the remaining hazards through use of engineering controls.

The risk assessment for the fluoridation plant and the effectiveness of actual control measures should be reviewed on a regular basis. Initial design risk control measures should not be degraded through subsequent modifications of the fluoridation plant and/or the water supply system. This is consistent with the approach taken in Water Safety Plans.

3.2.1 Risk-based systems

Risk-based systems include ISO 9001, ISO 14001, HACCP and local standards such as the Australian and New Zealand *Risk management – principles and*

[2] Refer section 2.1.5.

guidelines (AS/NZS ISO 31000). A risk-based system must be used to systematically address and manage risks associated with the fluoridation plant prior to commissioning.

3.2.2 Hazard and operability (HAZOP) studies

The drinking-water supplier should also conduct a Hazard and Operability (HAZOP) study as one part of the Safety in Design assessment. The HAZOP should involve the application of a formal systematic critical examination of the process and engineering intentions of the fluoridation plant to assess the hazard potential of inappropriate operation or malfunction of individual items of equipment and their consequential effects on the water treatment plant as a whole.

Any actions arising from the HAZOP study should be incorporated into the design and/or operation of the fluoridation plant.

3.3 Drinking-Water Safety

The performance objective is to ensure the design, construction, installation, operation and maintenance of the fluoridation plant protects public health by:

- Maintaining the optimum fluoridation concentration in the drinking-water supply
- Preventing overdosing of fluoride
- Implementation of quality assurance processes to guarantee the chemical purity of the fluoridating agent

Controls for managing risks to drinking-water safety, as identified through the site-specific risk assessment, must be incorporated in the drinking-water supplier's Water Safety Plan.

3.4 Occupational Health and Safety

The design and operation of the fluoridation plant must ensure worker safety. The drinking-water supplier must conduct and document a site-specific safety hazard risk assessment covering all aspects associated with the design and operation of the fluoridation plant.

The drinking-water supplier must ensure risks are assessed and managed in accordance with the relevant occupational health and safety requirements. The *Health and Safety at Work Act 2014* provides information and advice on eliminating hazards and controlling risks at the design, construction and operational stage to those involved in the design or modification of products, and processes used for work. Health monitoring of staff must be carried out to ensure that the hazard risk controls employed are functioning as intended. This is an employer responsibility required under the *Workplace Exposure Standards and Biological Exposure Indices*.

3.5 Environmental Safety

The design and operation of the fluoridation plant must not cause environmental harm. HSNO provides further details of the requirements that must be implemented to avoid this. The drinking-water supplier must conduct and

document a site-specific environmental risk assessment covering all aspects associated with the design and operation of the fluoridation plant, including the delivery, storage and handling of the fluoridating agent. Consideration of all aspects of environmental safety to do with the fluoridation chemical and plant should be evident.

4 Design of Fluoridation Plant

4.1 Design Criteria

4.1.1 Legislation, regulations, guidelines, standards and codes

The drinking-water supplier must ensure the design, construction and operation of the fluoridation plant complies with the relevant legislative requirements, guidelines and standards. These include, but are not limited to:

- Legislation - refer to Section 2
- NZS/AS 1319 *Safety signs for the occupational environment*
- AS 1345 *Identification of the contents of pipes, conduits and ducts*
- AS/NZS 1715 *Selection, use and maintenance of respiratory protective devices*
- AS 3780 *The storage and handling of corrosive substances*
- AS/NZS 4020 *Testing of products for use in contact with drinking water*
- AS/NZS ISO 31000 *Risk management – Principles and guidelines*
- AS/NZS 4452 *The storage and handling of toxic substances*
- AS/NZS 4801 *Occupational health and safety management systems—Specification with guidance for use*
- *NZS 5433.1&2: 2012, Transport of Dangerous Goods on Land*
- NZS 5807 *Code of practice for industrial identification by colour, wording or other coding*
- *Code of Practice for Manual Handling,* Published jointly by the Occupational Safety and Health Service of the Department of Labour and the Accident Compensation Corporation. June 2001
- Trade Waste Bylaws (if disposing of fluoride wastes to Council wastewater systems)
- Workplace Exposure Standards and Biological Exposure Indices

4.1.2 Chemical selection

The three chemicals used for the fluoridation of drinking-water in New Zealand are listed in Table 1.

The drinking-water supplier is responsible for selecting the most suitable fluoridating agent for the drinking-water supply. The selection process should

consider chemical availability and security of supply, whether a quality management system is in place to ensure chemical purity, site constraints and how the drinking-water supplier will comply with the DWSNZ. Evidence of the selection process (including a risk assessment) should be recorded.

Water New Zealand's Good Practice Guide *Supply of Fluoride for Use in Water Treatment 2014* should be used for specifying the supply of the chemical. The Good Practice Guide includes requirements for meeting the appropriate specification limits for contaminants using the Maximum Acceptable Value (MAV) approach as described in Chapter 1.5 of the DWSNZ.

The drinking-water supplier must undertake a risk assessment to ensure that any material used in the dosing of fluoride, such as soluble bags, do not present a risk to public health. The risk assessment must also ensure that the addition of contaminants in the fluoridation chemical to the concentrations of these contaminants already present as Priority 2 determinands in the supply, do not result in any contaminant exceeding its MAV.

Table 1: Fluoridating agents

Common name	Formula	CAS No.*	Alternative name(s)	UN Class	Hazard Classification**
Fluorosilicic acid	H_2SiF_6	16961-83-4	Hydrofluorosilicic acid (HFA), hexafluorosilicic acid	8, PG II	8.2C, 8.3A
Sodium fluoride	NaF	7681-49-4	Sodium monofluoride	6.1; PG III	6.1C, 6.3A, 6.4A, 6.6B, 6.8B, 6.9A, 9.1D, 9.3B
Sodium fluorosilicate	Na_2SiF_6	16893-85-9	Sodium silicofluoride, sodium hexafluorosilicate	6.1; PG III	6.1C, 6.4A, 9.3B

* CAS Numbers are as per the Chemical Classification and Information Database (CCID) on www.epa.govt.nz. Note that there are other CAS numbers in use for these chemicals.

** Classification as per the CCID on www.epa.govt.nz (chemicals in the CCID are classified in accordance with the Hazardous Substances and New Organisms (HSNO) regulations)

4.1.3 Concentration of fluoride in water

The purpose of fluoridation is to adjust the natural fluoride content of drinking-water to the optimum level to provide a dental health benefit. The target concentration of fluoride in treated water is between 0.7 and 1.0 mg/L.

The selected dosing concentration and the basis for the selection (including allowance for the fluoride concentration in the raw water) should be included in the Water Safety Plan. The drinking-water supplier should maintain a historical record of the fluoride concentration in the raw water to ensure an appropriate allowance is made for the fluoride concentration in determining the dosing concentration. The fluoride concentration in the raw water should be analysed at an appropriate frequency for the expected variability.

4.1.4 Design control limits

The design of the fluoridation plant must:

- Use a fluoride dosing concentration as determined using Section 4.1.3, and be controlled to the limits specified in Table 2.
- At no time allow the fluoride concentration in the drinking-water supply to exceed 1.5 mg/L (as specified by the MAV in the DWSNZ).

Real-time monitoring of the fluoride concentration after the dosing point (either direct or indirect), linked to an appropriate alarm monitoring system and automatic shut-down, is required - refer section 4.1.6. The fluoride plant control limits in Table 2 apply specifically to the instruments used for real-time fluoride monitoring, namely those instruments used for calculating instantaneous water flow and fluoride dose rates, and analyser/s for monitoring the fluoride concentration, if fitted.

Any delay time associated with the process limits in Table 2 (to account for instantaneous spikes) should be kept to a minimum, justified and documented.

Table 2: Fluoride plant control limits and alarms

Parameter	Total fluoride concentration (mg/L)	Response to process limits
Operating target	As determined by section 4.1.3.	–
Operating range (≥95% of the time that the fluoridation plant is In operation)	Within ± 0.15 of operating target.	–
Lower action process limit	0.6*	Dosing corrected. No shut down required.
Upper action process limit	1.2^	Immediate fluoride plant shut down. (Online monitoring system must be interlocked with the dosing system.)
Emergency process limit	1.5†	Immediate fluoride plant shut down. (Online monitoring system must be interlocked with the dosing system.) Notify the DWA Immediately, investigate the cause of the exceedance and take appropriate action. See DWSNZ for more information.

* NHMRC 2007, *A systematic review of the efficacy and safety of fluoridation*

^ This action level is a slightly lower dose than the maximum level of fluoride permitted in the DWSNZ, and has been established to ensure that the MAV is never exceeded.

† Based on the Maximum Acceptable Value set in DWSNZ.

4.1.5 Functionality of the fluoridation plant

To comply with this Code the fluoridation plant must be designed to meet the following requirements as well as the Independent Check requirements specified in Section 4.1.6:

a) The design of the fluoridation plant must ensure that provision is made for operational staff to monitor and control the fluoridation process reliably, accurately and in a timely manner.

b) The fluoride concentration in the water supplied for drinking must comply with the requirements set out in Section 4.1.3 and 4.1.4.

c) The plant must be configured so that the functionality requirements set out in 4.1.5, 4.1.6 and 4.1.7 are fully automated, and operated by a control system that is based at the treatment plant.

d) Plant design must ensure dependable automatic operation with reliable stopping and starting of the system during plant shut-down and start-up.

e) The plant must have alarms (including after hours to duty operator) and automatic shut-downs for key process elements.

f) If a day tank is used (see Section 4.1.6 for information about when day tanks are required as one of the Independent Checks):

   a. fluoride transfer from the bulk tank to the day tank must occur nominally once in a 24-hour period. Refer to Section 4.1. 6.

   b. it must be equipped with either an online weight measurement device or an online level instrument that enables measurement of the quantity of fluoride used during each 24 hour period.

g) If a bulk tank is used it must be equipped with an online level indicator or instrument and an easily readable graduated volume scale to reduce the risk of overfilling. When fluorosilicic acid is used the tank level must be displayed at the delivery connection point for the bulk tanker supplier.

h) Fluoride dosing must be flow-paced based on the measured water flow into which the fluoride is being dosed. Typically dosing will be achieved through use of a suitable flow meter and variable speed metering pumps. A secondary flow-based control device (for example, a flow meter or flow sensing device such as a flow switch) should be provided as backup to the main flow meter (i.e. in series).

i) The maximum physical dosing capacity of the fluoridation chemical feeding equipment must be limited by design to a maximum value that is as close as practicable to the operating target dose rate at the maximum water flow rate. This maximum value should not exceed 110 per cent of the operating target dose rate at the maximum plant capacity. For metering pumps which have a manual stroke adjustment, the component of the dosing flow that is able to be changed by manual adjustment of the stroke is excluded from this requirement, as long as the stroke adjustment is locked in position and its maximum operating position is clearly marked.

j) The drinking-water supplier must ensure that upon failure of the control system, treated water exceeding the emergency process limit in Table 2 does not enter the drinking-water supply system. This fail safe system would include metering pumps stopping and supply valves closing.

k) Metering pumps should be in a duty/standby arrangement. A duty/assist arrangement is acceptable, however the additional risk of control malfunctions should be considered.

This is not an all-inclusive list and further functionality requirements may be identified in the HAZOP and/or the safety-in-design phases. Alternatives to any of the requirements above may be used, as long as an equivalent level of safety, control and risk minimisation can be demonstrated as part of the peer review of the design.

4.1.6 Dose monitoring

To minimise the risk of overdosing of fluoride, a number of Independent Checks are required. For water supply systems that serve more than 10,000 people, at least two of the three following Independent Checks must be used. If the water supply system serves 10,000 or fewer people, then at least one of the three Independent Checks is required.

The checks are listed below:

Independent Check 1: Use of a day tank that can only be filled once a day and is equipped with an online device to measure its contents

Day tanks are commonly used with fluorosilicic acid fluoridation plants and can be used for sodium fluoride or sodium fluorosilicate. A day tank acts as a physical barrier that minimises the risk of large quantities of chemicals from the bulk storage tank (or if using powders, from the saturator or mixing tank) being added into the water supply in error.

To meet the requirements of Independent Check 1, the day tank must be fitted with an online device to measure its contents. This measurement device can be either a load cell or a level sensor:

- Level sensors measure and display the liquid level in the tank and generate alarms where operating parameters are exceeded. The accuracy of the sensors must be within ±1 per cent over the full range of the operational capability.
- Load cells measure and display the loss of mass in the tank and generate alarms where operating parameters are exceeded. The accuracy of the load cells must be within ± 1 per cent of the range being measured. Load cells are recommended (but not required) for measuring mass loss in the day tank as they are more reliable than level sensors.

Both level sensors and load cells can be used together to provide a higher degree of assurance but this is not a requirement.

Daily changes in the volume/mass of fluoride chemical consumed in the process must be recorded and used as an additional check.

Arrangements for the transfer of the fluoridation chemical from the bulk tank (or saturator or mixing tank) to the day tank must meet the following basic principles:

a) Transfer should occur through controlled pumping. Gravity transfer should be prevented by appropriate design (for example, an anti-siphon loop).
b) All equipment, pumps and day storage facilities should be located within a bunded area and chemical spillage must be captured in a safe manner. The bund volume must be in accordance with the *Code of Practice HSNOCOP 47 Secondary Containment Systems*.

c) The day tank must be sized for a maximum of 110% of the volume required for the maximum capacity and target dose rate. The day tank must not be filled more than once in any 24-hour period.

If using fluorosilicic acid, the day tank must be vented to the outside atmosphere and all connections sealed to prevent corrosion of the equipment in the room, or 'clouding' of any windows and damage to any electrical panels. A water trap should be provided on the tank overflow. The building should also include appropriate levels of ventilation.

Independent Check 2: Use of a fluoride measuring flow meter on the fluoride dosing line before the dosing point (only for (a) fluorosilicic acid, or (b) sodium fluoride from a saturator)

A flow meter before the dosing point is used to measure the amount of fluoride being added to the drinking-water. This flow meter must be linked to an appropriate alarm monitoring system and an automatic fluoridation plant shut down. These measurements must be compared with the operational target as an independent check of the quantity of fluoride dosed.

The dose flow meter must not be used as part of a feedback control to alter the dose rate. The flow meter's purpose is for alarming only and deviations from the expected dose flow should alert the operator so that they can determine the appropriate action.

The flow meter should measure the rate of flow and the SCADA must record the rate and total volume of flow. An electromagnetic flow meter should be used to achieve an accuracy of ±1-2%.

Independent Check 3: Fluoride concentration analyser on the drinking-water line after dosing point

A fluoride ion analyser is used after the dosing point to measure the concentration of fluoride in the final treated water. The sample point supplying the analyser must be located such that the measurement reflects the real-time dosing performance of the fluoridation plant. To achieve this requirement:

- The sampling point must be located such that adequate mixing has taken place before the sampling point
- The time taken for the sample to travel from the sampling point to the instrument should be kept to a minimum
- The sampling point must be before the first draw off for a consumer, and should be located upstream of the clear (or treated) water storage or, if downstream, at such a location that the measurement reflects the real-time dosing performance of the fluoridation plant.

The fluoride ion analyser should use the ion-selective electrode (ISE) analysis method or an alternative method that has been proven to be just as accurate. Accuracy to at least ± 0.15 mg/L should be achieved by a properly calibrated and well-maintained instrument in a production environment.

Interferences in the measurement using ion selective electrodes should be considered. Interferences are typically not an issue if the water has:

- Consistently low aluminium and iron levels (i.e. consistently below the aesthetic guidelines values in DWSNZ – 0.1 mg/L for aluminium and 0.2 mg/L for iron), and

- A relatively stable pH that is between 5.5 and 8.5.

If the water to be sampled falls outside this range a Total Ionic Strength Adjustment Buffer (TISAB) should be used, with the instrument able to alarm on exhaustion of the buffer.

All ISE analyses, including online ISE analyses, should be performed at a constant temperature, or results corrected for temperature, as ISE measurements are water temperature dependent.

Grab samples should be analysed at least weekly to check the calibration of the on-line analyser and the procedures in DWSNZ Appendix A2 (section A2.1) followed as if the testing is required for compliance. The samples should be analysed using a bench-top analyser (the ISE method, SPADNS method[3], the ion chromatography method, or other validated test method can be used for this purpose) and the results compared with those from the online analyser to ensure the accuracy of the online analyser.

In terms of DWSNZ, the drinking-water supplier must ensure the fluoride level in the treated water leaving the plant is analysed once a week (refer 5.1.3), by a laboratory recognised by the Ministry of Health.

Those undertaking fluoride analysis must be certified as competent analysts as if the analysis is required for compliance (refer section 3.1.1 of DWSNZ).

The analytical method used for both on-line and bench-top analysers must conform to (or be validated against) the reference methods in DWSNZ or the latest edition of *Standard Methods for the Examination of Water and Wastewater*.

4.1.7 Other design considerations

a) Water service off-takes

No drinking-water service within the plant or to consumers must be taken directly off the water line to which fluoride is dosed. This will provide additional

[3] The SPADNS (Sodium 2-(parasulfophenylazo)1,8-dihydroxy-3,6-naphthalene disulfonate) method is a colourimetric method for determining fluoride concentration in water. Fluoride ions react with the zirconium-SPADNS dye lake resulting in a loss of colour. The residual colour of the dye is then measured at 570 nm in a spectrophotometer. The concentration of the fluoride ion is inversely proportional to the intensity of the colour. This method is suitable for fluoride ion analysis in on-site laboratories.

time and volume for a high concentration of fluoride to be diluted if it has been increased above the upper action process limit.

b) Anti-siphonage, back-flow protection and pressure relief

The dosing system must be fitted with anti-siphon and pressure-relief valves (refer 4.4.3).

Any water supply used for dissolving the fluoridating agent or as carry water must have a backflow prevention device fitted upstream of where the fluoridating agent is dissolved or diluted (such as mixing tanks), or injected (such as metering pumps). In some situations backflow prevention may be achieved simply through using an air gap. Any backflow device must comply with the current New Zealand standards and with the Boundary Backflow Prevention for Drinking Water Supplies Code of Practice, June 2013.

c) Control equipment

It must be physically impossible for any component of the fluoridation feeding or control equipment to be manually plugged into standard electrical outlets for continuous operation if isolation of the power supply is used for the stop/start control of the dosing equipment. Any manual mode (or 'test') switch for the fluoridation chemical feeding equipment should not permit permanent selection (such as spring-loaded switches) and should return to the off position when released to prevent unattended manual operation.

All key components of the fluoride dosing control system must be interlocked to ensure total fluoride dosing system shutdown in the event of failure of any individual equipment item and to ensure that the dosing system cannot operate unless water is flowing. These key components should include, but are not limited to:

- Stop/start/pacing signals;
- Feeders;
- Metering pumps;
- Solution transfer pumps;
- Solution tank levels or weight;
- Dilution water pumps; and
- An online monitoring system.

Refer to Section 4.1.6 for the key overdosing controls.

An assessment of the possible causes of overdosing must be conducted during plant design and, where appropriate, interlocks and alarms designed into the system to prevent overdosing of fluoride.

d) Corrosion and dust suppression

Corrosion prevention measures should be implemented for all fluoridation plants.

Dust control measures should be implemented where sodium fluoride and sodium fluorosilicate are the agents used.

These measures will help protect the equipment, the operational staff and the neighbours surrounding the plant.

4.2 Equipment

All equipment used for adding fluoride to a drinking-water supply is required to operate in a safe, reliable and precise manner.

The drinking-water supplier must ensure that the equipment and associated controls have safety measures against over dosing and under dosing of chemical through human or operational malfunctions and that the equipment is safe to operate and maintain.

4.3 Chemical Delivery, Handling and Storage

The delivery, handling and storage of chemicals must be in accordance with occupational health and safety and environment protection requirements (including HSNO) to ensure the safety of staff, the community, the environment and the drinking-water supply.

4.3.1 Chemical delivery and quality assurance

Fluoride supply should be in accordance with the Water New Zealand, Good Practice Guide: *Supply of Fluoride for Use in Water Treatment 2014*.

The drinking-water supplier should ensure that the chemical supplier has a quality assurance system for the supply and delivery of the fluoridating agent to ensure its chemical purity, safe delivery and use. The quality assurance system should be implemented to manage all the factors associated with the specification, contract management, supply (including transportation), purity, storage, use and handling of fluoride compounds that could adversely impact upon the health and safety of staff, contractors and consumers. This quality assurance system should be included as part of the Water Safety Plan.

4.3.2 Bulk chemical storage

The drinking-water supplier should ensure that there is sufficient chemical available and readily accessible to ensure continuity of water fluoridation. The drinking-water supplier should document its assessment of storage requirements (taking into consideration availability of the fluoridating agent, transport, procurement strategies and itinerant populations).

Design of the bulk chemical storage should take into consideration:

a) Material selection (fit for purpose)
b) Safety in design for access, operation and maintenance ensuring compliance with relevant codes, guidelines and regulations
c) Separate chemical storage where required by the *Code of Practice HSNOCOP 47 Secondary Containment Systems*
d) Chemical storage bunding requirements as per the *Code of Practice HSNOCOP 47 Secondary Containment Systems*
e) Handling equipment for dry fluoride must be suited to the form and unit size of the delivered chemical
f) Spill removal and clean-up procedures
g) Ventilation and dust extraction as appropriate for the selected chemical
h) Measures to prevent corrosion (such as sealing all connections, water traps and ventilation)

i) Weather protection as appropriate
j) Controls and instrumentation including alarms, and visual display of tank contents
k) Security from unauthorised personnel (access control methods should be addressed as part of the HAZOP)
l) Safety and compliance of the chemical delivery area

4.3.3 Bag loaders/Vacuum Loading Systems

Where a dry fluoridating agent is used, the design of the plant should minimise airborne dust and the need for manual handling. Where manual handling is necessary, it should be in accordance with the *Code of Practice for Manual Handling* and the *Health and Safety at Work 2014*[4].

4.4 Chemical Mixing and Dosing

4.4.1 Mixers

Fluoride solutions should be homogeneous, irrespective of preparation method. Mechanical mixers should be used for the preparation of sodium fluorosilicate solutions.

4.4.2 Softeners

If using sodium fluoride, the fluoridation plant should include a water softener where the total hardness[5] of the water used for dissolving sodium fluoride chemical exceeds 75 mg/L as calcium carbonate. This requirement applies only to the water used to make up the fluoride solution in the mixing tanks and not to the main water supply being treated.

4.4.3 Metering pumps

Metering pumps must be able to accurately deliver the required flow rate, and be sized to operate at maximum output during the maximum flow that the treatment plant is designed to operate at. A safe method for calibrating dose rates must be available and maintained to ensure that the metering pumps are providing an accurate flow rate.

Any risk of gravity flow or siphoning of the fluoride chemical through the metering pump must be prevented. Siphoning can be prevented through use of an anti-siphonage trap, air gap or similar. A loading valve (or alternative such as an air break) on the delivery side of the pump shall be provided if gravity flow from the metering pump is possible.

Pressure relief on the delivery side of the pump or built into the metering pump must be provided. The pressure relieved at this point must be directed safely (e.g. back to the tank or bund).

When located within any bunded area, the transfer pump and metering pumps should be positioned above the maximum spillage level of the storage tank.

[4] Expected to replace the Health and Safety in Employment Act (1992).

[5] If water harder than 75 mg/L as $CaCO_3$ is used for dissolving the sodium fluoride in a saturator (i.e. producing a 4% w/w concentration fluoride solution), this will lead to excessive precipitation of calcium fluoride and magnesium fluoride from the fluoride solution.

4.4.4 Dry feeder systems

Dry feeder systems must meet the following requirements:

- Ensure accurate delivery of the required volume or weight of fluoridation chemical for the quantity of water being treated and must be sized for the maximum flow of the treatment plant
- The dry feeder, tank solution level, mixer, and metering pump must be controlled to meet the functionality requirements of Section 4.1.5
- Include a dust extraction system as specified in Section 4.3.3

4.4.5 Injection point

The location and detailing of the chemical injection point must:

a) Provide homogenous mixing (minimum coefficient of variance of 0.95) of the chemical in the treated water (where necessary mixing devices should be used) before the first take off or sampling point

b) Minimise loss of fluoride by precipitation with other chemicals (such as those containing calcium, aluminium and magnesium) or treatment processes (such as coagulation, filtration and pH correction), by dosing the fluoride following filtration and as far away as practicable after final pH correction if using lime

c) Minimise the possibility of siphonage and overfeeding

d) Include provision of a sampling point following mixing

e) Be located upstream of buffer storage of treated water

f) Not allow any bypass or secondary pipework (or channel) into which the fluoride chemical will not be dosed (except for fire-fighting purposes or other non-potable water).

g) Consider the impact of any recycle flow streams to avoid "double dosing".

4.5 Process Control and Instrumentation

Dosing fluoride into drinking-water is a continuous process with the objective of providing a lifetime exposure to fluoride for most consumers. It is therefore essential that the drinking-water supplier has a validated and verified system of accurately controlling fluoride dosing in place at all times.

As described in Section 4.1.6, two Independent Checks are required for plants that supply more than 10,000 people, and one Independent check is required when 10,000 people or fewer will be served. This is a minimum requirement for drinking-water suppliers for compliance with this Code. Those suppliers serving 10,000 people or fewer should consider the use of two Independent Checks.

In addition to the one or two Independent Checks, the following instrumentation must be provided:

a) Flow meter on the process stream into which fluoride is being dosed

b) Level, pressure or weight indicators on bulk tank

c) Alarm system to notify dosing abnormalities, particularly during unsupervised and after-hours periods

The following instrumentation is not a requirement for compliance with this Code but may

be used to improve control of the system:

a) Reference bench-top fluoride analyser to verify the performance of the online unit required by Independent Check 3
b) Both a load cell and level sensor on the day tank (only one is required for Independent Check 1).

All online instruments must be calibrated in accordance the manufacturer's recommendations as to method and frequency.

4.5.1 Flow measurement

A flow meter must be provided to measure and communicate the water flow, and to pace the fluoride dosing equipment over the full water flow rate range. The metered flow must be truly representative of the flow into which the fluoride is dosed.

The flow rate signal must be fed back from the meter to the fluoride dosing system to enable automatic adjustment of the fluoride dose rate. Use of electromagnetic flow meter or similar with an accuracy of ± 1 per cent over the complete range of flow is recommended. The accuracy must not exceed ± 3 per cent. The flow meter must be installed in accordance with the manufacturer's recommendations (particularly in relation to the length of straight pipe upstream and downstream of the meter).

4.5.2 Control and alarms

The fluoridation plant must generate alarms and respond to the fluoride action limits as specified in Table 2.

All dosing systems must be configured so as to be 'fail safe', that is, failure of a critical component automatically leads to the cessation of dosing and generation of an alarm. If it is not possible for the unit to fail safe, the PLC must be configured to ensure that fluoride will not be added to the water supply if a failure occurs. Loss of water to the online fluoride analyser must also generate an alarm.

All alarms, including fluoride concentration alarms, where online instrumentation is installed must inform a resource capable of immediate response even after hours. Where dosing is stopped during automatic operation that is outside of the normal operating parameters of the plant (either manually or by shutdown alarms), dosing must not restart automatically without manual on-site intervention.

Where automatic shutdown systems can be manually overridden (such as for maintenance purposes) any override events must be logged and the override facility configured such that the operator is aware that an override is activated (such as by the activation of a local or telemetry alarm).

The operation of shutdown systems must be fully tested at least annually and the outcome of these tests recorded. The testing procedure must be developed as part of the risk management planning as described in Section 3.2.

The fluoridation plant must generate alarms and respond to the fluoride action limits as specified in Table 2.

4.6 Plant Security

The drinking-water supplier must control access to the fluoridation plant to prevent unauthorised access which will minimise the risk of anyone being injured. Appropriate signage must be provided to indicate the presence of the fluoridating agent, any electrical or OHS hazard, and any required personal protective clothing or equipment, and that authorised entry only is permitted.

Access to the fluoridation plant should be restricted to authorised personnel through provision of a security locking system.

5 Operation and Maintenance

All plant and equipment used for adding fluoride to a drinking-water supply must operate in a safe, reliable and precise manner. The drinking-water supplier must ensure that the plant and equipment is well maintained.

5.1 Operational Monitoring and Verification Monitoring

5.1.1 Monitoring of fluoride concentration in the raw water

The fluoride concentration in the raw water should be analysed at least annually, but preferably biannually in summer and in winter. Prior to design, more frequent monitoring is suggested. The sample must be analysed for fluoride at a Ministry of Health recognised laboratory (which will be IANZ accredited). The analysis must be done using the same method as described in Section 4.1.6 for testing the fluoride concentration in drinking-water for Independent Check 3. The raw water fluoride concentration must be taken into account when designing and operating the fluoridation plant.

5.1.2 Quantity of fluoride dosed

Every 24 hours the mass of fluoride consumed by the plant (determined from the gross quantity of chemical used) must be calculated and divided by the volume of water that has passed the fluoride dosing point. This is another check of the average concentration dosed over each 24-hour period. Any inconsistencies must be investigated and remedial actions taken to bring the actual dose within the operating dose range (refer to Section 4.1.4).

5.1.3 Monitoring of the treated water

DWSNZ requires that the drinking-water leaving the treatment plant is tested for fluoride with a weekly sampling frequency at minimum. DWSNZ specifies that there cannot be more than 13 days between samples. Alternatively, fluoride sampling may be carried out in the distribution zone.

The sampling programme must be integrated into the Water Safety Plan under the DWSNZ for the drinking-water supplier and for any downstream water supplier receiving fluoridated water from the drinking-water supplier.

The drinking-water supplier must have a procedure to investigate and rectify 0.15 mg/L or more discrepancies between the monitoring results and the fluoride concentration as determined from the quantity of fluoride dosed and the Independent Checks.

5.2 Quality Assurance

The quality assurance system must ensure the fluoridation process is adequately monitored and maintained such that any discrepancy, equipment reliability issue or unacceptable variability in the final fluoride concentration is readily identified and effectively rectified.

The drinking-water supplier must also include the details of the quality assurance (QA) and quality control (QC) framework that will be implemented to verify the accuracy of the fluoride testing results, and the corrective actions and process by which operators will be informed in the event the fluoride dosing system is either under dosing or over dosing.

The QC framework must comprise activities (checks) designed to ensure:

- data integrity (consistency and accuracy)
- use of standardised procedures for sampling, analysis and data interpretation
- identification of errors or omissions, and estimation of uncertainties
- calibration of equipment
- credible results that relate to the data and analysis.

The drinking-water supplier must ensure that the Operations & Maintenance Manual (described in Section 6.3) is a controlled document with defined procedures/processes for amendment.

5.3 Maintenance and Calibration

The drinking-water supplier should carry out monthly plant inspections at a minimum and record in writing the outcome of the inspections and any resultant actions. In some instances, the HAZOP may determine that a more rigorous plant inspection regime is required. Plant inspections will help ensure effective process control, determine whether equipment is operating normally and identify the need for maintenance.

All equipment and instruments considered vital for process control must be maintained and calibrated regularly according to maintenance and calibration schedules documented or referenced to in the Operation & Maintenance Manual (see Section 6.3). Performance of metering pumps should be calibrated at least monthly by measuring the volume of solution pumped during a measured time interval.

Upon request, the drinking-water supplier must provide the DWA with evidence of maintenance and calibration of all plant items and equipment.

5.4 Operational Personnel

The drinking-water supplier must ensure that operational personnel (employees or contractors) are appropriately skilled and trained in the management and operation of the fluoridation plant, and that these competencies are maintained (and that this is documented in the Water Safety Plan). Operational personnel must have an adequate knowledge of the principles of fluoridation (including the risks), the type of plant or equipment and its operation and maintenance.

A National Certificate in Water Treatment (Site Operator) - Level 4 (or equivalent), or preferably a National Diploma in Drinking Water - Water Treatment (Site Technician) - Level 5 (or equivalent) is recommended as a minimum qualification for operators of fluoridation plants.

Operational personnel must have a sound knowledge base from which to make effective operational decisions. This requires training in the methods and skills required to perform tasks efficiently and competently. Operational personnel should be aware of the potential consequences of system failures, and how decisions made can affect the safety of the scheme.

5.5 Occupational Health and Safety

In the area of safety, and the handling and storage of dangerous goods, the *Health and Safety at Work Act 2014,* Hazardous Substance and New Organisms Act 1996 and associated regulations have precedence over this Code. If clarification is required in these areas then WorkSafe New Zealand will provide the defining interpretation.

The health and safety measures discussed below provide a basis for a drinking-water supplier to assess the control measures it should employ to manage occupational and safety risks associated with fluoridation systems. The control measures listed are not exhaustive and the use of these control measures (set out below) in no way ensures that compliance with the above mentioned Acts and Regulations is achieved.

Health and safety measures for consideration in the design and operation of a fluoridation plant include:

a) Safety in Design to ensure a safe working environment and facilitate safe working practices

b) Effective control measures are applied to mitigate risks as identified by the risk assessment

c) Adequate training for plant operators about the specific hazards associated with the fluoridating agent

d) Accessibility of the Material Safety Data Sheet (MSDS) for the fluoride chemical by maintaining the current MSDS in the Operation & Maintenance Manual, and providing a copy close to where the substance is used to enable reference to it by operators who handle the substance

e) Pipework and tanks used for storage and distribution of fluoride chemicals comply with the relevant standards and are appropriately distinguishable (for example, colour coded and labelled) from other plant pipework

f) The installation and arrangement of the equipment to ensure that the handling and operation of the equipment meet workplace health and safety requirements

g) Fluoridation equipment should be kept in a room or building separate from other water treatment plant equipment.

h) Electrical control panels for the fluoridation plant are protected and should be located outside the fluoridation room

i) The atmosphere of any areas where fluoridating agents are stored or used is safe for workers, and ventilation and dust extraction as appropriate is provided for the selected chemical

j) Appropriate personal protective equipment and hand washing facilities are

supplied and maintained by the drinking-water supplier at the fluoridation plant for mandatory operator use

k) Emergency eyewash/showers are available where fluoridating agents are stored and handled

l) Emergency skin treatment such as calcium gluconate gel or similar

5.6 Environmental Safety

The drinking-water supplier should ensure that the design and operation of the fluoridation plant does not result in environmental harm.
In its management of the fluoridation plant and ancillary equipment and activities, the drinking-water supplier must consider the Resource Management Act 1991 and relevant regional or unitary plans.

5.6.1 Spills and leaks

The drinking-water supplier must ensure the fluoridation plant and equipment is designed and operated to minimise the risk of fluoridating agent spills or leaks. Any spills or leaks must be contained and must not come into contact with or be stored with incompatible chemicals.

Where fluorosilicic acid is used then appropriately sized bunding with chemical resistant lining and other measures (such as drip trays) must be provided to contain any spillage. The design of bunding must facilitate the safe removal of any spillage, and be consistent with the Code of Practice HSNOCOP 47 Secondary Containment Systems and other relevant New Zealand standards. In designing the fluoridation plant, the inclusion of all components containing fluorosilicic acid (including the chemical feeding equipment) in the storage bund area should be considered as an effective way of reducing environmental risks.

Operating procedures must include measures for managing spills and leaks of the fluoridating agent, including in-built detection devices, surveillance, corrective actions and remedial works, and notification and reporting to the appropriate authorities. Fluoride piping should be visible so that it can be easily inspected for integrity. Where pipes are not visible, leak detection measures should be in place.

5.6.2 Release to the atmosphere

Where dry fluoridating agents are used, measures must be implemented to control dust. This includes designing the plant to prevent the escape of powder into the fluoridation room and atmospheric discharges.

Dry sweeping of dry fluoride chemical should not occur. If powder is spilt then it should be cleaned by vacuuming that is fitted with a HEPA filter to prevent dust. Operators must use personal protective equipment and this should be dictated in the Operation and Maintenance Manual.

5.6.3 Waste disposal

The management or the disposal of waste containing fluoride must be in accordance with the Hazardous Substance and New Organisms (HSNO) Act 1996. Wastes include fluoride chemical and plant and equipment that have been in direct contact with fluoride chemical.

The drinking-water supplier must document and implement an environmental waste disposal plan for fluoridating agent spills and leaks, contaminated fluoridating agent and fluoridating agent containers.

6 Documentation

6.1 Design Report

Water suppliers should document the design of new and upgrading of existing fluoridation facilities in a Design Report, which should include:

- The name of the drinking-water supply proposed to be supplied, including the WINZ identification numbers
- Plans and specifications including:
    - General description of facility and process including an outline of the overall treatment process, description of fluoridation facility, and the design capacity of the plant, expected minimum and maximum flows in normal operations and the expected growth of flows with time
    - A process and instrumentation diagram showing all key items by appropriate symbol
    - A location map, a site plan, and a ‘general arrangement’ showing the fluoridation facility in the context of the overall treatment plant
    - Evidence of the chemical selection process, natural fluoride content, optimum fluoride level and the dosage concentration
    - Fluoride design control limits, maximum pumping rate, feed rate and dosage calculations
    - Functionality of the fluoridation plant including details of intended process control, process and instrumentation (including process and instrumentation design), control philosophy for the proposed facility and integration into overall treatment process
    - Risk assessment as per Sections 3, 4.1.2, and 4.3.1, including the fluoridating agent selection process, quality assurance processes, supply and delivery risks, storage risks and the prevention or control of dosing risks associated with human error, plant malfunction and plant performance
    - Supplier of the selected fluoridating agent and that supply is in accordance with the Water New Zealand, Good Practice Guide: Supply of Fluoride for Use in Water Treatment.
    - Plans showing the spatial relationship (including levels) between the storage and metering facility and the dosing point, the relationship between the dosing points for fluoride and for any other chemicals added ‘post treatment’, and the pipeline layout from the dosing point downstream to the next component in the plant such as the clear water storage
    - Measurement of fluoride ion concentration in the treated water, monitoring programme and quality assurance
- A gap analysis against this Code providing justification for any deviations from the requirements of this Code and demonstrating an equivalent or greater level of safety
- Project plan including timelines
- Commissioning plan

Documentation of the fluoridation plant design should be incorporated in the drinking-water supplier's quality management system. Plant operational staff must be sufficiently trained so that they have knowledge of the location of these documents and are familiar with their content before commissioning. Operators that were absent from this training must be trained once the plant has been commissioned.

6.2 Completion of Work

Upon completion of plant construction and commissioning, the drinking-water supplier should maintain the following documentation:

- Operation & Maintenance Manual (refer section 6.3.)
- Emergency Management Plan (refer section 6.4)
- Commissioning records verifying that the fluoridation plant installation is in accordance with the plans and specifications and its operation is safe and reliable

6.3 Operation and Maintenance Manual

The Operation & Maintenance Manual must contain sufficient information to facilitate the operation and maintenance of the fluoridation plant by the operational staff. At minimum it must include:

- Standard operating procedures for the plant
- Maintenance and calibration schedules for items of equipment and instrumentation
- As-constructed drawings, equipment manuals, and functional description

The Operation & Maintenance Manual should be a controlled document which must be integrated into the drinking-water supplier's quality management system.

6.4 Emergency Management Plan

The drinking-water supplier must develop and implement an Emergency Management Plan to manage incidents and emergencies, including fluoride overdosing, spills entering the environment and operator exposure.

The Emergency Management Plan must address how the system will be managed to prevent any duration of fluoride concentrations over 1.5 mg/L (the MAV) reaching consumers.

An Emergency Management Plan must address:

- Procedures for shutting down the equipment in the event of overdosing
- The actions required to identify and rectify the problem
- Action required to advise and protect the public in the event of a significant overdosing event
- Reporting protocols including a clear chain of command and designated responsibility.

The Emergency Management Plan must be integrated into the Water Safety Plan or reference within it.

6.5 Record Keeping

The drinking-water supplier should keep records verifying that the fluoride plant is managed and operated in accordance with this Code, and with DWSNZ and section 69ZD of the Health Act. The records must be maintained and made available for inspection upon request by the DWA. Records include:

- Regular chemical analysis of fluoridating agent delivered
- Regular analysis of concentration of fluoride in raw water
- Plant and equipment calibration certifications and maintenance data
- Routine testing of critical alarms and corrective actions and outcomes of the system shutdown tests
- Surveillance monitoring and audits records
- Staff training records

The drinking-water supplier must, at a minimum, also record the following parameters at the frequencies indicated:

a) Continuously (minimum 5 minute interval records) as required by DWSNZ
   - Water flow
   - Online fluoride concentration (if Independent Check 3 is used)
   - Fluoride solution flow

b) Daily
   - The volume of water treated
   - The quantity of fluoride added to the water
   - The level or weight of the day tank prior to and after refilling or the volume of fluoride solution used (if a level sensor or load cell is fitted to the day tank for Independent Check 1)
   - The stock of fluoride on hand
   - The results of fluoride analysis of the samples of water taken from the treated water at the intervals required
   - Average fluoride concentration each day on the basis of the online analyser records (if Independent Check 3 is used)
   - Average fluoride concentration each day on the basis of the loss of mass or volume in the day tank (if using Independent Check 1)
   - A reconciliation of each of the Independent Checks

c) Weekly
   - Results from weekly sampling for fluoride content in the treated water

7 Reporting and Auditing

7.1 Annual Reporting

Water suppliers should provide the DWA with a report each year of their fluoridation systems. The annual report should include information required to demonstrate that the fluoride P2 compliance criteria within the DWSNZ has been achieved for the July - June period, and:

- The annual average, minimum and maximum fluoride concentration at each fluoridation plant
- The annual average, minimum and maximum fluoride concentration from the weekly samples in the water sampling localities, including a summary of any missed samples
- A summary of incidents and emergencies that were reported during the year
- A summary of the fluoridation process and chemicals used at each fluoridation plant (including any fluoridation plants operated by others that feed into that water supply being reported on)

7.2 Notification Requirements

The DWA must be notified of emergency and exceptional situations as described in Table 3. If the fluoride concentration in the drinking-water is less than the lower action process limit for a continuous period of >72 hours, it is not mandatory that the DWA be notified but it is encouraged.

7.3 Auditing

The drinking-water supplier's water fluoridation activities should be integrated into the Water Safety Plan.

Table 3: Emergency and exceptional notifications

Emergency and exceptional situation	Method of notification
Fluoride concentration in drinking-water supplied in a water sampling locality exceeds or may exceed 1.5 mg/L.	Notify the DWA Immediately, investigate the cause of the exceedance and take appropriate action. See DWSNZ for more information.
Fluoride concentration measured at the fluoridation plant exceeds 1.5 mg/L, however, does not enter the drinking-water supply.	This does not require a mandatory notification but the DWA should be notified. In addition, an internal investigation into the cause of the incident should be carried out and action should be undertaken and documented.
Fluoride concentration in drinking-water supplied is less than the lower action process limit for a continuous period of >72 hours.	This does not require a mandatory notification but the DWA should be notified.
If the rolling annual average fluoride concentration of drinking-water in a water supply has exceeded, or is expected to exceed, 1.0 mg/L in each quarterly compliance period.	The DWA should be notified.

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9 Further Information

To find out what New Zealand Health professionals think about fluoridation see:

- www.fluoridefacts.govt.nz
- For free download of the Water New Zealand guides see:
- www.waternz.org.nz and click on *publications*.
- See the website of your local District Health Board, or visit:
- Ministry of Health www.health.govt.nz and click on *Our Work* and then *Preventative Health/Wellness*
- Your local District Health Board's website
- New Zealand Dental Association www.nzda.org.nz
- New Zealand Medical Association www.nzma.org.nz
- National Fluoridation Information Service www.rph.org.nz

water NEW ZEALAND

The New Zealand Water & Wastes Association Waiora Aotearoa

A consistent approach across the 3 waters sector