VOL 1

water NEW ZEALAND
The New Zealand Water & Wastes Association Wairoa Aotearoa

WATER NEW ZEALAND
Good Practice Guide

FLUORIDATION OF DRINKING-WATER SUPPLIES IN NEW ZEALAND

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Foreword

Fluoride is added to drinking water to help protect against tooth decay. The Health Act grants the Director-General of Health decision making powers on community water fluoridation. Water suppliers will be required to fluoridate a water supply if directed to do so by the Director-General of Health. Those already fluoridating are required to continue to do so.

This guide has been developed to assist water suppliers in the design and operation of water fluoridation plants to enable effective addition of fluoride to water supplies in a manner which protects public health, and the operators who maintain them.

Formerly Water New Zealand had published a Code of Practice for Fluoridation of Drinking-water Supplies in New Zealand and the Good Practice Guide for Supply of Fluoride for Use in Water Treatment. Since this time the passing of the Health (Fluoridation) Amendment Act, and new Drinking Water Quality Assurance Rules, published by Taumata Arowai, New Zealand's drinking water regulator, both of which have shifted the roles and responsibilities in relation to the fluoridation of drinking water supplies. This Good Practice Guide has therefore been updated to ensure guidance on the fluoridation of water supplies reflects this shift.

The Code of Practice for Fluoridation of Drinking-water Supplies, was developed in conjunction with the Ministry of Health, supported by Victorian Department of Health, and received important contributions from a wide range of water suppliers and industry stakeholders. The Code of Practice specified optimum fluoride levels for drinking-water supplies as defined by the Ministry of Health and the design control limits for fluoridation plants, for safe and effective addition of fluoride into a drinking-water supply. Volume 1 of this guideline maintains the fluoride dose and control limits established in the Code of Practice.

Additionally, a Design Guidance document (Volume 2 of this Good Practice Guide) has been prepared b, in consultation with chemical, equipment and water suppliers. The content of Volume 2 reflects industry feedback on the most effective materials and means to achieve the safe and effective design and operation of drinking water fluoridation.

The Good Practice Guide for Supply of Fluoride for Use in Water Treatment was developed to provide purchasers, manufacturers and suppliers with minimum requirements for the physical, chemical and testing requirements for fluoride at the point of supply. Since then, Taumata Arowai has introduced Chemical Rules outlined in the Drinking Water Quality Assurance Rules, which provide new testing requirements for fluoride. Specific Impurity Limits for product testing using the approach developed in the Good Practice Guide for Supply of Fluoride for Use in Water Treatment are listed in Volume 2, Appendix A of this guide.

While there is no legal requirement to comply with these guidelines, they represent industry- endorsed good practice. If complied with, these guidelines provide a means of ensuring risks association with fluoridation in the water supply are satisfactorily mitigated. We encourage all water suppliers undertaking fluoridation to adopt the good practices outlined in these guidelines.

Acknowledgements

These guidelines have been produced in two volumes, both building on a significant body of industry experience and previous industry guidance.

Volume 1 of the Guide draws on the "Code of Practice for Fluoridation of Drinking-water Supplies". Updates to content were provided by Andrew Watson, Phillip Roche and Sarah Burgess of Beca, and funded by the Ministry of Health. This work develops on the significant body of work that went into the original code development, developed in conjunction with Ministry of Health, drawing on knowledge from the Victorian Department of Health, and receiving contributions from a broad range of industry stakeholders.

Volume 2 of the Guide has been authored by Iain Rabbits of Lutra, with support from Ciaran Hyland, with funding provided by the Water Service Managers Group. The guide draws on Lutra's experience designing fluoridation plants across New Zealand. Seaton Rolleston at IXOM and Mark Harrison at ChemFeed provided practical advice on products and material that fed into the guides development. Noah Hensley of Taumata Arowai, provided guidance on how fluoride will be managed under the new regulatory regime. John MacAndrew and Derek Crawford of Dunedin City Council provided suggestions on the types of information needed by water suppliers to manage fluoride dosing at water treatment plants.

"The Good Practice Guide for Supply of Fluoride Use in Water Treatment" impurity limits have also informed this guide. Product impurity limits set in the Good Practice Guide, and outlined in Volume 2, Appendix A of this document, were calculated by Chris Nokes, then employed by ESR, with review of several water and chemical suppliers. The specific impurity limits were updated to reflect any new maximum acceptable values by Iain Rabbitts

Water New Zealand wishes to acknowledge the authors of this document, previous fluoridation guidance, and the many contributors to past and present versions of their guides for their contribution to ensuring the safe and effective fluoridation of New Zealand's water supplies.

Contents

Abbreviations

Terms	Description
DWQAR	Drinking Water Quality Assurance Rules
FSA	Fluorosilicic Acid (see table 1 for other acronyms)
HACCP	Hazard analysis critical control point
HAZOP	Hazard and operability study
ISE	ion-selective electrode
MAV	Maximum Allowable Value
MSDS	Material Safety Data Sheet
$Na_2[SiF_6]$	Sodium silicofluoride
NaF	Sodium fluoride
SIL	Specific impurity limit
TISAB	Total Ionic Strength Adjustment Buffer

1 Introduction

Fluoridation is undertaken by drinking-water suppliers either as the result of a "Direction to Fluoridate" by the Director-General of Health, or at the supplier's discretion. The optimal range for oral health is in the range of 0.7 to 1.0 mg/L, as recommended by the Ministry of Health. The Good Practice Guide for the Fluoridation of Drinking-Water Supplies (this Guide) 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.

This guide is presented in two parts. The first volume covers the regulatory framework and specifies the minimum requirements for designing, operating and monitoring drinking-water fluoridation systems. The second separate volume presents guidance for the detailed design of the storage and dosing of the three alternative fluoridation chemicals used in New Zealand.

1.1 Objectives

The overall objective of this Guide is to ensure safe and effective addition of fluoride into a drinking-water supply.

The purpose of Volume 1 is to specify:

- 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.

The purpose of Volume 2 is to provide guidance for the design, storage and delivery control of fluoridation systems, that will fulfil these requirements, by providing:

    - Piping and instrumentation diagrams for equipment
    - Guidance on equipment sizing
    - Information on materials selection operations and considerations
    - Specific Impurity Limits for contaminants to ensure Maximum Allowable Values are not exceeded.

1.2 Scope

This guide is applicable to the design of all new and existing fluoride plants from the date of publication.

Volume 1 covers:

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

Volume 2 covers:

- Chemical Selection (Section 2)
- Fluorosilicic acid (Hydrofluorosilic acid) Design (Section 3)
- Sodium fluorosilicate (Sodium Silicofluoride) Design (Section 4)
- Sodium Fluoride Saturator System Design (Section 5)
- Specific Impurity Limits (Appendix A).

1.3 Terminology

Good Practice Guide for the Fluoridation of Drinking-Water Supplies: 'this Guide'

Drinking-water Supplier: The Water Services Act (2021) defines a drinking-water supplier as a person who:

a) supplies drinking water to people through a drinking -water supply, and

b) includes a person who ought reasonably to know that the water they are supplying is or will be used as drinking water; and

c) includes the owner and the operator of a drinking water supply; and

d) includes a person described in paragraph (a), (b), or (c) who supplies drinking water to another drinking water supplier; but

e) does not include a domestic self-supplier.

Water Services (Drinking Water Standards for New Zealand) Regulations 2022: 'the DWSNZ'

Fluoride concentration: The fluoride concentration refers to the total amount of fluoride ion present regardless of its form and is expressed in milligrams per litre (mg/L) (Note: 1 mg/L = 1 g/m^3 = 1 ppm (w/v)).

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.

Guidelines for Drinking-water Quality Management for New Zealand: Guidelines to help water suppliers to comply with the Water Services Act.

Health and Safety at Work (Hazardous Substances) Regulations 2017 (Hazardous Substances Regulations).'

Health Act 1956: The Act that enables the Director-General of Health to direct a local authority to add fluoride or not to add fluoride to drinking water supplies.

Safeguards: A suite of six requirements that all must be in place to minimise the risk of overdosing of fluoride (refer section 4.4)

Maximum Acceptable Value: 'MAV' as defined by the Water Services (Drinking Water Standards for New Zealand) Regulations 2022

'Must' and 'should'

The word 'must' identifies a mandatory requirement for compliance with this Guide.

The word 'should' refers to practices that are advised or recommended but are not mandatory for compliance with this Guide.

2 Regulatory Framework

This section outlines legislative requirements of relevance to the management of water fluoridation.

2.1 Legislation

2.1.1 Health (Fluoridation of Drinking Water) Amendment Act 2021

'The Health (Fluoridation of Drinking Water) Amendment Act 2021 shifted decision-making on fluoridation from water suppliers to the Director-General of Health. The change allows for a nationally-consistent approach to community water fluoridation based on its health benefits.

Water suppliers will be required to fluoridate a water supply if directed to do so by the Director-General of Health. Those already fluoridating are required to continue to do so.

In deciding whether to make a direction to fluoridate, the Director-General of Health is required to consider:

- scientific evidence on the effectiveness of adding fluoride to drinking water in reducing the prevalence and severity of dental decay
- whether the benefits of adding fluoride to drinking water outweigh the costs, including consideration of local oral health status, population numbers, and financial cost.

2.1.2 Water Services Act 2021

The Water Services Act provides a drinking water regulatory framework to ensure that safe drinking water supplies are provided to consumers. The act gives Taumata Arowai the legal authority to carry out its duties as New Zealand's dedicated water regulator. Taumata Arowai are the water services regulator for Aotearoa New Zealand, responsible for developing regulatory instruments (such as Rules, Standards and Acceptable Solutions).

Taumata Arowai publish Drinking Water Standards and Drinking Water Quality Assurance Rules. The Drinking Water Quality Assurance Rules (Rules) set out what drinking water suppliers need to do to comply with key parts of the Drinking Water Standards and the Water Services Act 2021 and set monitoring requirements that apply to fluoride.

2.1.3 Water Services (Drinking Water Standards for New Zealand) Regulations 2022

These regulations, which come into force on 14 November 2022, set the Drinking Water Standards for New Zealand. The standards set limits for the concentration of determinands in drinking water. The limits are referred to as maximum acceptable values (MAVs) including fluoride. The MAVs for any determinand must not be exceeded at any time.

2.1.4 Other Relevant Legislation

- Health Act 1956 (2022)
- Health and Safety at Work Act 2015
- Health and Safety at Work (Hazardous Substances) Regulation 2017
- General Risk And Workplace Management Regulations 2017.

- Local Government Act 2002

2.1.5 Other relevant standards

In addition to ensuring that the design, construction and operation of the fluoridation plant complies with the relevant legislative requirements, additional standards relevant to the operation of fluoride plants include, but are not limited to:

- Code of Practice HSNOCOP 47 Secondary Containment System
- NZS/AS 1319-1994 Safety signs for the occupational environment
- AS 1345-1995 Identification of the contents of pipes, conduits and ducts
- AS/NZS 1715-2009 Selection, use and maintenance of respiratory protective devices
- AS 3780:2008 The storage and handling of corrosive substances (class 8 and 6)
- AS/NZS 4020:2018 Testing of products for use in contact with drinking water
- AS/NZS 4360:2004 Risk management
- ISO 9001:2015, ISO 14001:2015, Quality management and environmental hazard control systems
- AS/NZS 4452:1997 The storage and handling of toxic substances
- AS/NZS 4801:2001 Occupational health and safety management systems
- NZS 5807:1980 Code of practice for industrial identification by colour, wording or identification
- NZS 5433:2020 Transport of Dangerous Goods on Land
- 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 published by Worksafe.

2.2 Drinking Water Safety Plans

A Drinking 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. All water suppliers are required to have a Drinking Water Safety Plan. Documentation of compliance with the safeguard requirements of Volume 1 of this Guide is deemed to meet the risk assessment requirements of the Drinking Water Safety Plan in relation to fluoridation.

2.3 This Guide

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

The Guide 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.

2.4 Roles and responsibilities

2.4.1 Taumata Arowai

Taumata Arowai is the water services regulator for New Zealand. Their function is to regulate the provision of drinking-water services and protect public health by ensuring communities receive safe drinking-water. They regulate drinking water safety through the use of Quality Assurance Rules, Quality Standards and Aesthetic Guideline Values. Water suppliers who fluoridate need to make sure that they comply with these requirements.

2.4.2 Manatū Hauora - Ministry of Health

The function of Manatū Hauora is improving, promoting, and protecting public health. The Director-General of Health has powers under the Health (Fluoridation of Drinking Water) Amendment Act 2021 to direct drinking-water suppliers to add or not add fluoride to drinking-water supplied by them. Water suppliers that were adding fluoride to their drinking-water supply prior to the commencement of the Amendment Act must continue to add fluoride to their drinking-water supplies unless directed not to do so by the Director-General of Health. Water suppliers are also encouraged to add fluoride to their drinking water supplies in the absence of a direction. The addition of fluoride to drinking-water in the range 0.7 - 1 mg/L is a safe, effective, and affordable way to prevent and reduce tooth decay across the whole population.

2.4.3 Drinking-water Supplier

For new and upgraded fluoridation plants, drinking-water suppliers are recommended to design, construct and operate the fluoridation plant in accordance with this Guide.

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 Drinking Water Safety Plan for a drinking-water supply.

Prior to the construction of a fluoridation plant, the drinking-water supplier should have the design peer-reviewed against this Good Practice Guide, to demonstrate that the plant will operate in a safe and effective manner.

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.

Drinking-water suppliers must be able to demonstrate they are not exceeding the MAV for fluoride to Taumata Arowai and that they are meeting the optimal range for fluoridation to Manatū Hauora. At the time of publishing this Guide, Manatū Hauora is developing a process for suppliers to demonstrate that fluoride is being provided within the optimal range. Compliance with these requirements is beyond the scope of this Guide.

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. The Health and Safety at Work Act 2015 requires designers to, as far as is reasonably practicable, make sure that structures, plant or substances to be used in a workplace are without health and safety risk, among other duties.

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

- Drinking-water safety for consumers
- Occupational health and safety
- Environmental 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 Drinking 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 standard (AS/NZS 4360). 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

Hazard and Operability (HAZOP) studies are conducted by water suppliers 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 promotes and protects public health by:

- Maintaining the optimum fluoride concentration in the drinking-water supply
- Minimising the risk of 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, should be incorporated in the drinking-water supplier's Drinking 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.

It is the responsibility of the drinking-water supplier to ensure risks are assessed and managed in accordance with the relevant occupational health and safety requirements. The Health and Safety at Work Act 2015 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.

4 Design of Fluoridation Plant

4.1 Fluoridation chemical types and selection

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

Each chemical has different storage, handling, delivery and dosing requirements, different chemicals are suitable for different applications. Chemical selection considerations are outlined in Volume 2 of this guideline.

Evidence of the selection process (including a risk assessment) should be recorded.

Table 1: Fluoridating agents

Common name	Formula	CAS No.*	Alternative name(s)	UN Class	Hazard Classification**
Fluorosilicic Acid (FSA)	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 (SFS)	Na_2SiF_6	16893-85-9	Sodium silicofluoride (SSF), 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)

Volume 2 Appendix A of this Good Practice Guide outlines the appropriate specification limits for contaminants using the Maximum Acceptable Value (MAV) approach of the DWSNZ.

Undertaking a risk assessment will enable drinking water suppliers to ensure that any material used in the dosing of fluoride, such as soluble bags[1], do not present a risk to public health. The risk assessment should also cover the addition of contaminants in the fluoridation chemical, combined with the concentrations of these contaminants already present in the supply, to ensure these do not result in any contaminant exceeding its MAV.

[1] Note that soluble bags, which are available in Australia for sodium fluoride, are not currently available in New Zealand.

4.2 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. Dosing fluoride into drinking-water is a continuous process with the objective of providing a lifetime exposure to fluoride for all consumers. The target concentration of fluoride in treated water is 0.85 mg/L, with variation between 0.7 and 1.0 mg/L allowed.

The dosing concentration (including allowance for the fluoride concentration in the raw water) should be included in the Drinking 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.

4.3 Design control limits

The design of the fluoridation plant should:

- Use the fluoride target dosing concentration as specified in Table 2 and be controlled to the limits specified in Table 2.
- At no time allow the fluoride concentration in the drinking-water supply to exceed the MAV, specified n the Water Services (Drinking Water Standards for New Zealand) Regulations 2022). At the time of publication this is set at 1.5 mg/L.

Safeguards linked to an appropriate alarm monitoring system and automatic shut-down, are required refer section 4.4. 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 ion concentration (mg/L)	Response to process limits
Operating target (to be achieved for ≥95% of the time that the treatment plant is producing water)	0.85 mg/L.	
Operating range (≥95% of the time that the fluoridation plant is in operation)	Within ± 0.15 of operating target.	–

Upper action process limit	1.3^	Immediate fluoride plant shut down (safeguards must be interlocked with the dosing system.)
Emergency limit	1.5†	Immediate fluoride plant shut down. (Safeguards must be interlocked with the dosing system.) Notify Taumata Arowai, investigate the cause of the exceedance and take appropriate action.

* 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 minimise the risk that the MAV is exceeded.

† Based on the Maximum Acceptable Value set in Water Services (Drinking Water Standards for New Zealand) Regulations 2022.

4.4 Safeguards

Overdosing of fluoride chemicals can lead to adverse health effects to consumers, as well as a loss of confidence in the safety of a supply. The following safeguards (A, B, C, D, E and F) must be in place for all fluoride dosing systems as a minimum. Volume 2 outlines design guidance that provides for these safeguards.

A) Flow Proportional Dosing

Dosing shall be controlled in proportion to the measured water flow at the fluoride chemical dose point. Refer Section 4.7.5 for detailed requirements for flow measurement.

B) Dosing Capacity Limit

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. Means shall be provided to enable the calibration of the dose pump.

C) Flow Measurement at Dose Point

Dosing should only operate when a positive water flow is measured at the point where the fluoride chemical is dosed. Two independent means should be used to verify water flow for large supplies (> 500 people). A flow switch, that reliably switches at an intermediate flow between the plant minimum flow and zero flow may be used as one of these for large supplies that require a second independent means.

Note serious overdosing events have occurred as a result of errant flow signals, including where a pipeline was drained, causing the flow meter to send random flow signals – such risks should be considered as part of the risk analysis.

Note that the HAZOP should consider the risks of failure to shut off fluoride supply on plant stop, and in particular where the dose point is at a lower level than the dose tank whether a loading valve provides sufficient safeguard or whether a more positive shut off such as an actuated valve is warranted.

D) Day Tank Mass/Volume Monitoring.

Fluoride is dosed from a day tank (applicable to fluorosilicic acid or sodium fluoride), or day hopper (SFS).

The total volume of the day tank/hopper shall not exceed 110% of the volume of chemical that would be dosed in a day at the maximum capacity of the treatment plant.

Chemical may be transferred to the day tank more than once every 24 hours if a proportionally smaller tank is designed for. For example, the design period for transfers could be every 12 hours, in which case the tank/hopper volume shall be less than 110% of the volume expected to be used at the maximum capacity of the treatment plant in 12 hours.

The day tank/hopper must be equipped with either an online weight measurement device or an online level instrument (level only applicable to liquid chemical solutions) that enables measurement of the quantity of fluoride used during each 24-hour period (or lesser design period). Accuracy of the level/weight measurement shall be to better than ± 1% of the range being measured.

The quantity of fluoride used each day provides an independent check of the amount of fluoride chemical dosed.

Transfer must not occur more frequently than the design period (i.e. 24 hours, or less if the design period selected is less than 24 hours).

Transfer should occur through controlled transfer. Safety measures shall be considered in the HAZOP. Gravity transfer should be prevented by appropriate design. An anti-siphon loop or positioning the dose tank below the day tank is preferred, however an actuated valve is acceptable.

E) Treated Water Fluoride Analysis

Online monitoring of the fluoride concentration in the fluoride dosed water shall be undertaken. Note this requirement over rides the DWQAR T1 and T2 rule in which on line analysis is not required. Refer to Section 4.7.6 for detailed requirements.

F) Treated Water Storage

There shall be a storage tank between the dose point and any consumer, in order to buffer short term concentration variations. This tank shall have a minimum 15 minutes nominal hydraulic retention time at maximum flow.

4.5 Functionality of the fluoridation plant

4.5.1 Design requirements

The fluoridation plant must be designed to meet the following requirements as well as the Safeguards specified in Section 4.4:

a) The design of the fluoridation plant must ensure that provision is made for operational staff to operate, monitor control, and maintain the fluoridation process safely, reliably, accurately and in a timely manner. Refer Section 5.5 for health & safety measures for consideration during design.

b) The fluoride concentration in the water supplied for drinking must comply with the requirements set out in Sections 4.3 and 4.4.

c) The plant must be configured so that all the functionality requirements set out in Section 4 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) 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 fluoride supply valves closing (where applicable).

g) Metering pumps should be in a duty/standby arrangement. A duty/assist arrangement is acceptable, however the additional risk of control malfunctions must 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 may be used, as long as an equivalent level of safety, control and risk minimisation can be demonstrated and signed off as part of the peer review of the design.

4.5.2 Other design considerations

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

The dosing system must be fitted with an anti-siphon valve.

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 high hazard device requirements of AS/NZS3500.

b) 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 4.4 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.

Fluorosilicic acid bulk and day tanks should be fully sealed, including water traps on overflows, and the tank headspace vented to outside the building, to minimise corrosion risks. Ventilation around dosing areas should be considered to minimise corrosion risks.

4.6 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 Hazardous Substances Regulations) to ensure the safety of staff, the community, the environment and the drinking-water supply.

4.6.1 Chemical delivery and quality assurance

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 Drinking Water Safety Plan.

4.6.2 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 guidance is provided in Volume 2.

4.6.3 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.

4.7 Chemical mixing, dosing and analysis

4.7.1 Mixers

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

4.7.2 Softeners

If using sodium fluoride, the fluoridation plant should include a water softener where the total hardness 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.

4.7.3 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 4.5.
- Include a dust extraction system to meet the requirements of Section 4.6.3.

4.7.4 Injection point

The location and detailing of the chemical injection point must:

a) Provide homogenous mixing (minimum coefficient of variance of 0.05) 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".

4.7.5 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).

4.7.6 Fluoride Sampling and Analysis

An online fluoride ion analyser is used after the dosing point to measure the concentration of fluoride in the final treated water. The sample point supplying an analyser (or a grab sampling tap) 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 (or plant service water offtake), and should be located upstream of the treated water storage. Where chlorine contact is separate to treated water storage, the sampling point may be after chlorine contact, prior to treated water storage.

The sole purpose of the online fluoride ion analyser is to provide an independent check of the quantity of fluoride that has been added to the drinking water flow. It must not be used to provide feedback for trimming the fluoride chemical dose rate.

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 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 taken at a frequency that accords with the instrument manufacturer's instructions (but at least monthly) to check the calibration of the on-line analyser. The samples should be analysed using a bench-top analyser (the ISE method, SPADNS method, 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. Periodic (at least quarterly) checks against an IANZ accredited analysis shall be completed.

4.7.7 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. Software interlocks are acceptable. Loss of sample 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.

4.7.8 Plant security

The drinking-water supplier should 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 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 needs to operate in a safe, reliable and precise manner. This requires the drinking-water supplier to 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 ion 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 ion concentration at an IANZ accredited laboratory. The raw water fluoride ion concentration must be taken into account when designing and operating the fluoridation plant.

Should significant variation in natural fluoride ions be found, this needs to be taken into account in the dosing system operation, which may require a fluoride analyser prior to fluoride dosing to inform the operator of the correct fluoride dose.

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 4.3).

5.1.3 Monitoring of the treated water

Monitoring of the treated water shall comply as a minimum with the Quality Assurance Rules requirements. Requirements of this Guide should also be complied with. The sampling programme must be integrated into the Drinking Water Safety Plan.

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 required by the Safeguards (Section 4.4).

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 overdosing.

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 should 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.

Drinking-water suppliers should have evidence of maintenance and calibration of all plant items and equipment to provide Taumata Arowai on request.

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 2015, 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

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 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 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 Regulations. 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 Taumata Arowai identification numbers
- Plans 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.
    - Process and instrumentation diagrams showing all key items by appropriate symbol.
    - 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, and 4.5.1, including the 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 complying with the Maximum Allowable Values outlined in Volume 2, Appendix A.
    - 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
- Commissioning plan.

Documentation of the fluoridation plant design should be incorporated in the drinking-water supplier's Drinking Water Safety Plan. 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 should 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 & 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 Drinking 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 Guide, with the Drinking Water Standards and the Quality Assurance Rules. The records must be maintained and made available for inspection upon request by Taumata Arowai. 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/where required by the Drinking Water Quality Assurance Rules

- Water flow
- Online fluoride concentration (where monitored)
- Fluoride solution flow (where monitored)

b) Daily

- The volume of water treated
- The quantity of fluoride added to the water (based on day tank or hopper and dose flow meter, where monitored)
- 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 – on site and IANZ accredited samples
- Average fluoride concentration each day on the basis of the online analyser records (where monitored)
- Average fluoride concentration each day on the basis of the loss of mass or volume in the dosing tank (if using day tank)
- A reconciliation of each of the independent checks (refer Safeguard D and Section 4.7.6)

7 Reporting and Auditing

7.1 Annual reporting

Reporting of compliance with the Taumata Arowai Quality Assurance Rules is required.

For supplies providing water to populations greater than 500 people fluoride levels in water leaving a treatment plant must be continuously monitored. The rules that relate to continuous monitoring in the Drinking Water Quality Assurance Rules must be complied with. These water suppliers must report annually to Taumata Arowai the number of days in each year that fluoride levels in water leaving a treatment plant complied with the MAV set for fluoride in the Drinking Water Standards.

For supplies providing water to between 101 and 500 people, Taumata Arowai requires that fluoride levels in water leaving a treatment plant must be analysed twice weekly. These water suppliers must report annually to Taumata Arowai the number of weeks in each year that fluoride levels in water leaving a treatment plan complied with the MAV set for fluoride in the Drinking Water Standards. The Taumata Arowai fluoride analysis requirements for these supplies, are lower than those specified in this Good Practice Guide which specifies on line analysis.

The Ministry of Health may require further reporting on minimum fluoride levels and will advise water suppliers of these requirements.

7.2 Notification requirements

Taumata Arowai must be notified of emergency and exceptional situations as described below under Emergency and Exceptional Notifications.

Fluoride concentration in drinking-water supplied in a water sampling locality exceeds or may exceed 1.5 mg/L.

Notify Taumata Arowai Immediately, investigate the cause of the exceedance and take appropriate action.

Fluoride concentration measured at the fluoridation plant that exceeds 1.5 mg/L, however, does not enter the drinking-water supply.

This does not require a mandatory notification, but Taumata Arowai 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 0.6 mg/l for a continuous period of >72 hours.

This does not require a mandatory notification, but Taumata Arowai 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.

Taumata Arowai should be notified.

Bibliography

Taumata Arowai, 2022, Drinking Water Quality Assurance Rules, Wellington, New Zealand. Available at:

https://www.taumataarowai.govt.nz/assets/Uploads/Rules-and-standards/Drinking-Water-Quality-Assurance-Rules-2022-Released-25-July-2022.pdf

American Water Works Association, *Sodium fluoride standard (ANSI/AWWA B701-18).* AWWA, Denver.

American Water Works Association, Sodium fluorosilicate standard (ANSI/AWWA B702-18). AWWA, Denver.

American Water Works Association, *Fluorosilicic acid (ANSI/AWWA B703-19).* AWWA, Denver.

American Water Works Association, Water Fluoridation principles and practices, Manual of water supply practices (6th edition). AWWA, Denver.

Code of Practice HSNOCOP 47 Secondary Containment Systems, 2012. Environmental Protection Authority. New Zealand. Available at:

https://www.worksafe.govt.nz/assets/dmsassets/2/2269WKS-1-hazardous-substances-ACOP-Secondary-containment-systems.pdf

Standard methods for the examination of water and wastewater (24th Edition) 2012. Published by American Public Health Association, American Water Works Association and Water Environment Federation, Washington.

Further information

Manatū Hauora information on fluoride:www.fluoridefacts.govt.nz

New Zealand Dental Association www.nzda.org.nz

National Fluoridation Information Service www.rph.org.nz