CHAPTER 5

OPERATION OF FLUORIDATION SYSTEMS

5.1 INTRODUCTION

It is important, in the proper operation of any fluoridation system, that complete and accurate records be kept on proper chemical storage and handling and fluoride analysis.

It is important that fluorides be fed accurately at the water treatment plant. Frequent determination of the fluoride content of water samples is one way to confirm the adequacy of fluoridation. The results of such laboratory testing for fluorides reveal the concentration at the instant the sample was collected. This chapter will discuss the optimal fluoride levels recommended for community fluoridation and will address methods that can be used for analyzing fluoride.

5.2 RECORD KEEPING

5.2.1 Introduction

Comprehensive record-keeping allows efficient operation and maintenance of the water supply system. Since the size and design of water supply systems vary, record keeping methods are best tailored to each design. Without permanent records describing the system, a community becomes dependant upon the memories of long-time employees. Valuable information can be lost with the retirement of each employee. Records demonstrate that an operator is attempting to maintain system reliability.

There are two types of records: those required by law and/or regulations and those required for operation.

5.2.2 Required Records

In terms of Section 10 of the Regulations on Fluoridating Public Water Supplies the follow-ing information is required to be recorded and to be reported on:

“1. The local authority or water provider where applicable in terms of the agreement be- tween them, shall record the following particulars daily for the first month after com-missioning a water fluoridation plant, and thereafter daily or any other period not ex-ceeding seven days:

(a) the volume of water fluoridated after the last recording;

(b) the amount of fluoride used in the water referred to in paragraph (a):

(c) the calculated theoretical average fluoride concentration of fluoridated water leaving the plant after the last recording;

(d) the calculated theoretical average of the fluoride concentration, based on his-torical information or on actual measurement, in the unfluoridated water which entered the water fluoridation plant after the last recording;

(e) the average monthly fluoride concentration in the fluoridated water leaving the water fluoridation plant, as recorded by the fluoride monitor as well as the highest and lowest fluoride concentration in such fluoridated water during that month;

(f) the average monthly fluoride concentration in the samples as well as the highest and lowest fluoride concentration in such samples during the month;

(g) remarks on an events such as breakdowns, equipment, failure, repairs, main-tenance or any other activity that may have an effect on the fluoride concen-tration referred to in paragraph (c), (d), (e) and (f) and if stepswere taken to prevent the recurrence of such events or activities".

2. The amount of fluoride referred to in subregulation (1)(b) is determined by the sub-straction of the amount of fluoride in stock at the end of the present period from the sum of the amount of fluoride received on site after the last recording and the amount of fluoride in stock at the beginning of the present period.

3. The average fluoride concentration referred to in subregulation (1)(c) is determined by the following factors:

(a) the volume of the water referred to in subregulation (1)(a);
(b) the amount of fluoride added to such water; and
(c) the fluoride content of the unfloridated water referred to in subregulation (1)(d).

4. A monthly summary of the records referred to in subregulation (1) shall be submitted by a local authority or water provider to the health department of such local authority and to other health authorities concerned, together with a report on any non-compliance with subregulations (1)(5) or (6) of this regulation and the steps to prevent recurrence of such non-compliance.

5. Any incident of an overdose of more than 1,5 mg fluoride per litre for more than 24 hours or a major spill of fluoride must be recorded and immediately reported to the health department of the local authority and other health authorities concerned.

6. The records and reports referred to in subregulation (4) and (5) must be open for public inspection.

7. A summary of the records and reports referred to in subregulation (4) and (5) must be submitted by the local authority concerned to -

(a) the MEC of Health of the responsible Provincial Government every three months; and
(b) to the Director-General of the national Department of Health annually."

5.2.3 Operational Records

Obviously, operational records are necessary to improve the operation of the fluoridation system. These records will vary greatly depending on the individual water system and the region. Generally, these records should include the chemical quality of the raw water (natural fluoride content, pH, etc.); the quantities of water pumped (from the master meter), and data on the maintenance of the fluoride metering pumps, motors, piping, etc. Records also should

be maintained on the calibration curves made. Information from the vendors for parts, repairs, etc., should also be kept readily available. Additional information, such as when the equipment was last checked, repaired, and lubricated and when chemicals were added, should also be maintained. Records can help remind the operator what maintenance has to be done and when it is time to do it again.

If the operator already keeps maintenance records on other equipment in the water plant, then the fluoridation equipment can be included in whatever record system is used.

There are many ways to keep maintenance records. Some operators make out a schedule for an entire year and post it on a wall. This schedule shows the maintenance jobs planned for each month and when a job is completed, the date is added. Other operators mark maintenance jobs on a calendar, a reminder of the work to do. A record of what they actually do is kept in another place such as in a card file (with a separate card for each piece of equipment) or in an equipment record book.

With experience, the operator will probably want to change the frequency of some maintenance jobs. For example, suppose the records showed that some part always wore out before it was scheduled to be replaced--the operator would probably want to change the maintenance schedule and routinely replace the part more often.

Also, the maintenance schedule should be adjusted whenever equipment is taken apart to make a repair. For example, if the equipment has not received it's routine maintenance the routine maintenance of the equipment may be done while it is disassembled. The next routine maintenance can then be rescheduled starting from the date of the repair.

5.3 CHEMICAL STORAGE AND HANDLING

A number of criteria govern the selection of a storage site for fluoridating chemicals: Dry chemicals must be kept dry and convenient to the hopper; preferably they should be isolated from other water treatment chemicals to preclude accidental intermixing; the storage area must be clean and well
ventilated, and should be equipped with running water and a floor drain for ease in cleaning up spills.

Dry fluoride compounds, i.e., sodium fluoride and sodium fluorosilicate, have a tendency to compact or cake when exposed to moisture or when bags are stacked too high. Similar conditions can result from long periods of storage, so an oversupply of chemicals should be avoided. Store dry fluorides on pallets, in stacks preferably not more than six bags high. If fiber drums are used, keep the tops closed to prevent moisture absorption. Do not allow unauthorized personnel, especially small children, in areas where fluoride chemicals are fed or stored.

When fluoride sacks are handled carelessly, or if the bags are emptied too quickly, airborne fluoride dust levels may become dangerously high. Do not toss the bags. When opening the bags, cut an even slit across the top to avoid tearing the sides. Pour the contents of the bags gently into the feed hopper. Do not bellows the empty bag. Good ventilation is absolutely necessary in work areas, even if there is no visible dust production.

The disposal of empty fluoride containers has always been a problem. Do not re-use empty fluoride containers! The temptation to re-use fiber drums is strong, since the drums are convenient and sturdy. Paper bags are dusty and could cause a hazard if they are burned. The best approach is to rinse all empty containers with plenty of water, even the paper bags are strong enough to withstand repeated rinses. After all traces of fluoride are removed, the bags should be disposed of in a proper manner. Even supposedly well-rinsed drums should never be used where traces of fluoride could present a hazard. If possible, the storage area should be kept locked and not be used for any other purpose. Workers should particularly be warned against eating in a fluoride storage area.

Fluorosilicic acid presents particular storage problems, for the vapors are corrosive and will even etch glass. Containers must be kept tightly closed and vented to the outdoors. Large quantities of acid can be stored in underground or enclosed tanks equipped with outside vents. The 30 percent acid has a freezing point at -15,5°C. The 100 percent acid will freeze at -20°C. Do not store fluorosilicic acid containers in the hot sun where the containers can build hydrostatic pressure, or in open areas subject to winter freezing.

Fluorosilicic acid should be stored in well ventilated areas, well away from switches, contacts, and control panels. Although the acid is available in all-polyethylene drums, some suppliers continue to ship it in lined steel drums that may suffer leakage problems. Wash down all spills immediately.

When fluorosilicic acid is purchased in bulk, tanks are necessary for storage. Bulk storage tanks can be made of fiberglass (coated with epoxy resin), polyethylene, or rubber-lined steel. The polyethylene should be manufactured from high density cross-linked material (cross-linked provides strength). The plastic should contain a minimum of 0.25 percent ultraviolet stabilizer to protect against sun light. The polyethylene storage tanks are still relatively new so the longevity of the tank is yet to be determined. Fiberglass and rubber-lined steel tanks are used about equally for bulk storage of fluorosilicic acid. Fiberglass tanks usually will last about 7-10 years. Several years ago, fiberglass tanks were the most popular; then, the steel tanks became the most popular; now, the polyethylene bulk storage tanks are the most frequently purchased. The steel tanks are always lined with rubber. Most linings are made of natural rubber but can be made of neoprene or butyl rubber. Butyl rubber is best, however, it's the most expensive. The steel-rubber-lined tanks will last about 20 years.

5.4 CALCULATIONS FOR FLUORIDATION SYSTEMS

5.4.1 General

Prior to the operation of any fluoridation system, some basic calculations should be made. While these calculations can be done several ways, the results should be the same. One method of the calculation is described in this manual, Ervin Bellack, in his "Fluoridation Engineering Manual," uses another. Operators have their own individual ways of doing the basic calculations, and all are usually correct. Some operators use short cuts, such as nomographs, or constants, to get the same answers. Most fluoridation engineers or technicians will develop their own style. This material is offered as one way to do the basic fluoridation calculations.

5.4.2 Optimal Fluoride Level

The optimal fluoride level in South Africa will range between 0,5 - 0,7 mgF_/l. For a particular area in South Africa the optimal fluoride level will be determined through general agreement between water and health authorities in the area concerned.

Because water consumption in a community varies depending on air temperature, optimal fluoride levels are based on the average of the annual maximum daily air temperatures in the specific area.

Since a 20 percent drop in fluoride levels can produce a 50 percent drop in benefits, setting a higher level for the bottom of the recommended fluoride control limit helps to ensure that the benefits of fluoridation are maintained even if the level in the water varies slightly.

The Department of Health has formulated water quality criteria to promote the safety of the drinking water being produced by the various water suppliers. The maximum allowable fluoride level of community water systems are contained in a document titled: “Health Guidelines: Drinking Water Quality”, is shown in table 5.1 and are based on the concept of health risk ranges.

TABLE 5.1
GUIDELINE VALUES FOR FLUORIDE CONTENT IN DRINKING WATER

DETERMINANT	HEALTH RISK RANGES			
	NONE	INSIGNIFICANT	LOW	GREATER
Fluoride (mgF_/l)	< 1.0	< 1.5	< 3.0	> 3.0

Although for the sake of convenience four risk concentrations areas are defined, it is important to note that for example a concentration that nears the upper value of the “insignificant health risk area”, is already inclined to indicate a “low health risk”.

The four different health risk areas on which the criteria are based are:

1. **The no health risk area:** This is the primary water quality limit, and is the limit that ideally should be strived for. The no health risk area has a built-in safety factor, and thus no immediate danger exists where this limit is exceeded.

2. **The insignificant health risk area:** As the no health risk area can often be exceeded in practice by one or more determinants in a given water sample, it is necessary to define a less stringent secondary limit, the insignificant health risk area. This area is still a safe one, but should not normally be exceeded.

3. **The low health risk** may constitute a minimal health risk to individuals. When water with a low health risk has to be used, special considerations have to be taken into account such as:

   No alternative economic water source is available.

   Composition of the users (adults, children, expectant mothers and old people) has to be considered.

   Users should be informed and taken note of the low health risk they may be exposed to.

   The medical and hospital personnel concerned should correspondingly be informed.

4. The **greater (unacceptable) health risk area**: This tertiary limit is defined as “that limit where extreme action must be taken”. The area thus represents that level at which serious health effects may occur if the water in question is consumed for any length of time.

5.4.3 Dosage

The unit of expression, milligrams per liter, is used in laboratory work to indicate very small concentrations. It is a weight/volume relationship. Milligrams per liter (mg/l) and parts per million (ppm) are equivalent so long as the liquid used has a density (specific gravity) of 1.0 grams per cubic centimeter (the specific gravity of water is 1.0). In this manual the terms ppm and mg/l are used interchangeably. While mg/l is the preferred term, ppm is used in many instances in the interest of clarity or tradition. (Note: The term "ppm" is a unitless expression).

The dosage is defined as the amount of fluoride chemical needed to be added to obtain the optimal fluoride level in the drinking water.

The dosage, expressed as milligrams per liter (mg/l) or parts per million (ppm), is obtained by subtracting the naturally occurring fluoride level from the desired fluoride level. For
example, if the desired fluoride level is 0.7 mg/l and the natural fluoride level is 0.2 mg/l of
of the water to be fluoridated, the dosage is:

Dosage (mg/l) = Optimal level (mg/l) - Natural level (mg/l)
= 0.7 mg/l - 0.2 mg/l
= 0.5 mg/l.

5.4.4 Maximum Pumping Rate (Capacity)

There is usually some confusion over the terms used to describe the flow rate used in the design of fluoride feeders. Three terms will be used in this manual: the maximum pumping rate or plant capacity; average daily production rate; and the actual daily production.

The maximum pumping rate, or plant capacity, refers to the maximum amount of water that can be produced. The capacity of a water plant may be measured in liters per minute or megaliter per day. The plant capacity is a set amount that is limited by factors such as the size of the pumps, area of the filters, etc. (There are some instances where there may be a difference between the maximum pumping rate and the plant capacity.)

It is important to note that the sizing of a fluoride feeder is based on the maximum flow rate at the point of injection referred to in this manual as the maximum pumping rate or plant capacity.

It is this maximum pumping rate, or plant capacity, which must be used to determine the fluoride feed rate. The fluoride must be added at the correct proportion to raise the fluoride to the optimal level, regardless of how many hours per day the plant is in operation, since the fluoride feeder will be functioning only when there is flow occurring at the fluoride injection point.

The average daily production rate is the average amount of water produced on a daily basis. The average production rate of a plant in megaliter per day can be used to estimate chemical costs. Average daily production rate for a water plant is usually significantly less than the capacity of the plant.

The actual daily production is the amount of water actually treated or produced during a 24-hour period. It is used to determine the calculated dosage. There usually is a difference between the maximum pumping rate or plant capacity and the actual amount of water a water plant treats each day. A plant may operate at a capacity of approximately 1.0 megaliter per day; however, if the plant only operates 12 hours per day, it will only treat 0.5 megaliter. In this case, the plant capacity would be 1 megaliter per day and the actual daily production would be 0.5 megaliter.

5.4.5 Chemical Purity and Available Fluoride Ion (AFI) Concentrations

It is well known that it is the fluoride ion from which dental benefits are obtained. Several chemical compounds used today form fluoride ions in a water solution and also meet water quality standards. For each chemical, the fluoride ion is bound with other chemicals, such as sodium, silica, etc.hence, only a portion of the chemical is available as a fluoride ion when it is dissolved in water. As supplied by the chemical manufacturers, the chemicals used in fluoridation are not 100 percent pure. The following chart gives the available fluoride ion concentration (AFI) and is the most common purity for the three commonly-used chemicals for fluoridating water systems:

TABLE 5.2
AVAILABLE FLUORIDE ION FOR FLUORIDE CHEMICALS

CHEMICAL	FORMULA	PURITY	AVAILABLE FLUORIDE ION CONCENTRATION (AFI)
Sodium Fluoride	NaF	98%	0.452
Sodium Fluorosilicate	Na_2SiF_6	98.5%	0.607
Fluorosilicic Acid	H_2SiF_6	23%	0.792

If the available ion concentration is multiplied by the chemical purity, the product represents the actual portion of the chemical available as the fluoride ion after it is dissolved in water. For example, sodium fluoride contains 45 percent F- and has a commercial purity of 98 percent to yield:

% available fluoride = % F-x % commercial purity
% available fluoride = 0.45 x 0.98 % available fluoride = 0.44
Available fluoride ion concentration is abbreviated as AFI in the calculations that follow.

5.4.6 Fluoride Feed Rate

Adjusting the fluoride level in a water supply to an optimal level is accomplished by adding the proper concentration of a fluoride chemical at a consistent rate. To calculate the fluoride feed rate for any fluoridation feeder in terms of kilograms of fluoride to be fed per day, it is necessary to determine the dosage, maximum pumping rate (capacity), chemical purity, and the available fluoride ion concentration, as previously shown.

The fluoride feed rate formula is a general equation used to calculate the concentration of a chemical added to water. It will be used for all fluoride chemicals except sodium fluoride when used in a saturator. (Note: As stated in Section 5.4.3, mg/l is equal to ppm.) The formula for the fluoride feed rate (the amount of chemical required to raise the fluoride content to the optimal level) is as follows:

$$\text{Chemical feed rate (kg/d)} = \frac{\text{D x PR (megaliter/day)}}{\text{AFI x P}}$$

Where:

D = dosage, in mg/l
PR = plant rate, in megaliter per day
AFI = available fluoride ion, decimal fraction
P = chemical purity, decimal fraction

Some times it is required that records be kept of the amount of chemical used and that the theoretial concentration of the chemical in the water be determined mathematically. This number the calculated dosage, is a safety precaution that helps ensure that an overfeed or accident does not occur. It also aids in solving troubleshooting problems. If the calculated dosage is significantly higher or lower than the measured concentration, steps should be taken to determine the reason for the discrepancy. The following equation can be used to determine the calculated dosage (in milligrams per liter):

$$\text{Calculated dosage (mg/L)} = \frac{\text{Kilograms of chemical x AFI x P}}{\text{PR}}$$

The numerator of the equation represents kilograms of fluoride ion added to the water and the denominator represents millions of liters of water treated.

A saturator-type feeder is unique because the strength of the solution formed is always 18 000 mg/l. This is due to the fact that sodium fluoride solubility is practically constant at 4.0 g/100 ml of water at the temperatures generally encountered in water treatment. Each litre of solution contains 18 000 mg of fluoride ion (40 000 mg/l times the percent available fluoride [45 percent] equals 18 000 mg/l. The constant strength simplifies calculations by eliminating the need for weighing the chemicals. The volume of solution added to the water is all that is needed; for a calculated dosage in milligrams per litre, this volume value is provided by a meter on the water inlet of the saturator. Thus, the feed rate is simply

$$\text{Feed rate} = \frac{\text{Plant capacity x Dosage (mg/l)}}{18\ 000}$$

The feed rate will have the same units as the capacity. If the capacity is in litre per minute, the feed rate will also be in litre per minute.

The formula for the calculated dosage (in milligrams per litre) for the saturator is as follows:

$$\text{Calculated dosage (mg/l)} = \frac{\text{Liters in saturator x 18 000}}{\text{Liters of } H_2O \text{ treated}}$$

5.5 CHEMISTRY OF FLUORIDE ANALYSIS

5.5.1 Introduction

The analysis of fluoride in water involves the determination of the quantity of fluoride present in solution, irrespective of the source of that ion. There is no method capable of distinguishing natural fluoride from added fluoride, thus the fluoride test results will be in terms of total fluoride. (But remember that the test for total fluoride does not include insoluble fluorides or the organic fluorides.)

Because the recommended concentrations of fluoride in potable water are so small, the analytical method must be precise and highly selective. Methods based on classic gravimetric or volumetric techniques are generally not applicable.

Years ago, only the colorimetric methods were suited to the measurement of minute quantities of fluoride. Today the analyst may elect to use the fluoride specific ion electrode test rather than the traditional colorimetric fluoride test (SPADNS). Either method has the required sensitivity, the electrode method, however, has far fewer interferences.

5.5.2 Interferences with Fluoride Analysis

The substances that interfere with the analysis of the fluoride ion are shown in Table 5-1. As can be seen, some of the interferences for the colorimetric (SPADNS) method occur at quite low concentrations. These low concentrations are definitely within the range that occurs in water plants during normal operation. However, most of the interfering substances will be fairly constant in ground water systems, so it is quite easy to account for this interference in the daily monitoring results. It's only when the interfering substance fluctuates widely, as in surface water systems, that either the distillation step or the use of the specific ion electrode method needs to be considered for daily monitoring of the fluoride level.

5.5.3 Fluoride Sampling Collection

The reliability of an analysis of the concentrations of fluoride in a water sample depends upon the sampling method. The water samples must be representative of the water to be examined. In other words, water samples must be collected at a point where the fluoride has become completely mixed with the entire volume of water entering the distribution system. Otherwise, the results will have no significance.

If a sample is collected from a tap, the water should first be run long enough to empty the service pipe and thus obtain a sample representative of the water in the main.

It is not possible to specify the sampling points in general that would be applicable to a particular water supply. The important point is that the samples for analysis show the fluoride content of the water delivered to the consumer. A possible sampling point could be from a water tap in the home of the plant operator, if the operator's house is served by the distribution system being tested.

Water samples should be taken and tested for fluoride at least daily by the plant operator. In some locations the operator may be required to test more than once a day.

The state may require a certain number of water samples to be submitted each month for fluoride analysis. These are called check samples. (At least one check sample should be taken per month.) When collecting such water samples, it is good practice to collect two samples at the same time: one for submission to the state laboratory and one for analysis by the plant operator. Comparison of these two results can verify the accuracy, or point out any discrepancy, in the results of the tests.

5.5.4 Electrode Method for Fluoride Analysis

The electrode method is capable of measuring fluoride concentrations from 0.1 to 10 ppm. A major advantage of the electrode method is that samples generally do not require distillation to eliminate the interferences.

The basis for this method is in the fluoride electrode itself. Most electrodes contain a fluoride solution;

Solution; at the tip of the electrode is a crystal doped with fluoride ions. The crystal acts as an ionic conductor, so that when the fluoride concentration outside of the electrode is higher than that inside, ions move toward the inside, setting up a voltage potential proportional to the difference in fluoride concentration. Conversely, when the fluoride concentration on the outside is lower than that on the inside, a proportional potential or opposite sign is set up. In most fluoride electrodes, the internal solution is about 10^{-3} molar in fluoride, so concentrations below 19 ppm result in positive voltage readings. Some electrodes contain no internal solution, but the principle of operation is similar.

5.5.5 SPADNS Method for Fluoride Analysis

The colorimetric method, or SPADNS photometric method, is based on a reaction in which a dye lake (a deep color) is formed with zirconium and SPADNS dye.2 (SPADNS is sodium 2-(parasulfophenylazo)-1,8-dihydroxy-3,6-naphthalene disulfonate.) Any fluoride present in the water sample removes zirconium from the reaction, thus decreasing the intensity of color present. The color of the reaction mixture (water sample plus reagent) varies from very deep red in the absence of fluoride to light red when the concentration of fluoride is high.

TABLE 5-3
INTERFERING SUBSTANCES*

Concentration of substance, in mg/l, required to cause error of plus or minus 0.1 mg at 1.0 mg/l fluoride

Interfering Substances	SPADNS	Electrode
Alkalinity (CaCO3)	5,000 (-)	7,000 (+)
Aluminum (Al)	0.1 (-)	3.0 (-)
Chloride (Cl)	7,000 (+)	20,000 (-)
Iron (Fe)	10 (-)	200 (-)
Hexametaphosphate ([NaPO3])	1.0 (+)	50,000
Phosphate (P04)	16 (+)	50,000
Sulfate (S04)	200 (+)	50,000 (-)
Chlorine	Must be completely removed with arsenite	5,000
Color & Turbidity	Must be removed or compensated for	

The colors produced by different concentrations of fluoride ions are all shades of red, and it is almost impossible to detect the difference in these colors by eye. It is necessary to use a photometer to detect the color differences and therefore determine the concentration of fluoride in a water supply. A photometer is an instrument for detecting differences in color, and consists of a light source, a filter for producing monochromatic light, and a photocell for measuring the intensity of the light transmitted through the sample.

The procedures for using the photometer for analysis of the fluoride concentration in a sample of water consist of adding a measured volume of reagent to a measured volume of the water sample, placing a portion of the mixture in a cell or curvette, placing the cell in the instrument, and determining the fluoride concentration in parts per million (ppm) from the instrument scale.

The fluoride analysis of water is a comparatively delicate operation, as the quantities involved are minute, and the greatest possible accuracy is desired For these reasons, the following special precautions should be taken with any of the SPADNS procedures.

Ensure that the temperature of the standard sample and the water sample is the same, preferably approximately 20 degrees (± 1 degree) C. If the temperatures of the standard and the unknown are different, then the results will not give a correct reading of the fluoride content.

Ensure that glassware is clean and free from scratches and chips. In the fluoride test, the concentration of fluoride being determined is extremely small. Any fluoride test is very sensitive to small residues of various chemicals that can interfere. Therefore, it is absolutely necessary that the colorimeter bottles and all other glassware be clean. To make sure of the accuracy of the test, it is strongly recommended that the fluoride test be repeated as a check, using the same graduated cylinders and colorimeter bottles. Repeating the test will ensure that the glassware is free of interfering chemicals.

Measure the reagent accurately (use pipette for SPADNS).

If chlorine is present, it should be eliminated, using arsenite solution.

To standardize the test equipment, use a standard fluoride solution that has a fluoride content close to what the fluoride content should be for the sample being tested. For example, if the routine test samples have about 1.5 ppm fluoride, it is recommended that a 1.5 ppm standard fluoride solution be bought and used rather than the 1.0 ppm solution.

Perhaps the most important source of error is the presence of interfering ions in the water sample. None of the colorimetric methods are entirely specific for fluoride, and, to varying degrees, many of the other ions found in water affect the fluoride analysis. The reagents are
designed to eliminate the effects of these interfering ions, or to minimize the effects as much as possible. However, if a water supply contains a large quantity of interfering ions, the reagent may not be able to minimize the effects of the interfering ions enough to get an accurate determination of the quantity of fluoride in the water. If the interferences become a problem, the ion electrode method should be considered

The SPADNS method of fluoride analysis is directly applicable to fluoride samples in the range of 0.1 to 2.0 ppm. Beyond this range, dilutions must be made using deionized water to obtain accurate measure of the fluoride concentration. Dilutions must be carefully made. The colorimetric (SPADNS) method of fluoride analysis is subject to variable interferences caused by certain chemicals (e.g. alum) used in water treatment.

5.5.6 Continuous Monitors

A continuous monitor is a device that automatically monitors the fluoride ion concentration and provides a continuous record of the fluoride level. The advantage of a continuous record over a spot check, such as a daily fluoride analysis, is that the continuous record will show the fluoride concentration at any given time rather than only at the time the daily sample is taken. This type of record could prove helpful in answering complaints regarding under- or over-feeding, as well as in detecting variations in fluoride concentration for unexplained reasons. If the monitor is equipped with an alarm system, it can alert the operator to feeder malfunctions or other problems affecting fluoride level.