

CHAPTER SEVEN

SAFETY

7.1 Introduction

While fluoride is an extremely safe compound at the 1ppm level found in water supplies, the operator may be exposed to much higher levels by handling the chemicals. Therefore the use of safety equipment is strongly recommended when handling fluoride compounds or performing maintenance.

7.2 Fluoride Chemicals

Always wear protective safety gear when handling fluoride chemicals. The following is a list of protective clothing and equipment, which is the minimum recommended for each fluoride chemical.

I. Sodium fluoride/sodium fluorosilicate

1. Wear protective clothing.
 - a. NIOSH/MSHA approved high efficiency dust respirator (chemical mask) with soft rubber face-to-mask seal and replaceable cartridges*
 - b. Goggles
 - c. Gauntlet neoprene gloves (12" glove minimum length)
 - d. Heavy duty neoprene aprons
 - e. High top boots

Protective clothing should always be worn whenever sodium fluoride/sodium fluorosilicate is handled and should be stored near the entrance to the area where the sodium fluoride is stored and used. This clothing should not be worn into other parts of the water plant to avoid spreading sodium fluoride dust. Handle bags of sodium fluoride/sodium fluorosilicate carefully.

2. Don't tear or puncture bags when they are moved; use a knife to open the bags and make a clean cut.
3. Pour the sodium fluoride into the saturator gently, so as to raise as little dust as possible; empty opened bags completely.
4. Do not store partially filled bags of sodium fluoride for later use.
5. Dispose of empty bags as required by your state.

Wash your hands immediately after handling sodium fluoride, the fluoridation equipment, or your protective clothing. Never eat, drink, or smoke in areas where sodium fluoride is stored and used.

*The NIOSH/MSHA approval is given to various masks. Each brand is evaluated by NIOSH/MSHA for the proposed use and conditions.

II. Fluorosilicic acid

1. Wear protective clothing.
 - a. Gauntlet neoprene gloved (12" glove minimum length)
 - b. Full 8', face shield and/or acid type safety goggles
 - c. Heavy duty acid type neoprene aprons
 - d. Safety shower/eye washer in easily accessible location (or pint bottle of eyewash solution)
 - e. Boots
2. Keep the acid off clothes and skin and don't breathe in its fumes when handling the acid.
3. Use a transfer pump to move acid from one container to another.
4. Mop up any spilled acid immediately and wash the area with water.
5. Dispose of empty acid containers as required by your state.
6. Wash your hands after handling fluorosilicic acid, the fluoridation equipment, or your protective clothing. Do this immediately, before you do anything else.
7. Never eat, drink, or smoke in areas where the acid is stored or used.

Chemical respirators with cartridges for acid fumes should be worn if the concentration is sufficient to cause irritation to the nose.

Spill control pillows can be used to clean up small fluorosilicic acid spills. The liquid is absorbed and contained within the pillow by a highly efficient "foamed-sand" type of absorbent, which is chemically inert and can absorb up to 10 times its weight. The pillows are commercially available in various sizes ranging from 1 to 4 liters.

Water plant personnel should regularly receive safety training on all chemicals, including fluoride. Hazards and first aid measures should be reviewed and explained. Emergency spill procedures should be established and personnel trained in the execution of those procedures. Safety records show that the water treatment plant personnel have one of the highest accident/injuries rate in the United States. Until water plant managers/supervisors insist on proper safety training and utilization of safety equipment, this poor record shall continue.

7.3 Fluoride Exposure

7.3.1 Toxic Exposure

While potable water with fluoride levels at the recommended concentration of 1.0ppm has been exhaustively studied and firmly established as safe beyond question, the fluoride levels to which the water plant operator can be exposed are potentially much higher. To prevent overexposure, the best safety measure is proper handling of fluoride chemicals. Proper handling implies adequate knowledge of the material, the practice of correct procedures, and the use of indicated safety equipment.

There are times, however, that the operator may be overexposed to the fluoride chemicals, especially the dusts. These overexposures, whether they occur in water or air, are called toxic exposures. The two kinds of toxic exposures are chronic toxic exposure and acute toxic exposure. A clear distinction must be made between chronic toxic exposure to large doses of fluoride over a number of years and acute toxic exposure, which results from a single massive dose.

7.3.2 Chronic Toxic Exposure

The only toxic effect of low levels of fluoride over a prolonged period (2 to 8 times that of the optimal level) is mottled enamel of the teeth. At higher levels of fluoride intake, osteosclerosis, calcification of ligaments and tendons, and/or vertebrae consolidation can occur. With chronic toxic exposure from fluoride chemical dusts, there may be a general lack of appetite, slight nausea, some shortness of breath, constipation, pain in the liver region, and anemia.

Probably the greatest chance for chronic exposure to fluoride chemicals comes from the inhalation of dust generated when the feeder hoppers are being filled. To prevent overexposure during the filling operation, the operator should wear an effective NIOSH approved respirator, an apron, and rubber gloves. The respirator should have a rubber face-to-mask seal, with replaceable cartridges. Cartridges are available for either dust or acid vapor application. The maximum allowable concentration of fluoride dust in the area (TLV) should be 2.5 mg/m³ of air.

7.3.3 Acute Toxic Exposure

Acute fluoride poisoning may result from ingestion, inhalation or bodily contact with concentrated fluoride compounds. Not a lot is known about acute fluoride poisoning caused by ingestion or inhalation because it is a very rare occurrence. Accidental ingestion is quite unlikely, but might occur by the compound being mistaken for sugar or salt or through carelessness or allowing areas where food is consumed to become grossly contaminated by dust or spillage.

The symptoms of acute poisoning by inhalation of dust or vapor include sharp biting pains in the nose followed by nasal discharge or nosebleed and perhaps coughing or respiratory distress. These symptoms generally start at approximately 10 mg per cubic meter of air. Acid spill or splash may cause a tingling or burning sensation of the skin, or if the eyes are involved severe eye irritation.

Ingested toxic overdoses generally cause vomiting, stomach cramps, and diarrhea. If the poisoning involves ingestion of large amounts of fluorides, the vomitus may be white (or colored if the fluoride contains dye), and the victim may experience muscular weakness, articulation difficulty, disturbed color vision, and thirst. The final stages of fluoride intoxication would include weak pulse, unconsciousness, and convulsions. Ingestion of 5 to 10 grams of fluoride (as sodium fluoride) per 154 pounds of bodyweight may be fatal.

Several bodily functions help prevent an acute dose of fluoride from being fatal. First, there are the initial symptoms of severe nausea and vomiting when high levels of fluoride are ingested. Second, at lower levels of ingestion, individuals in a stable fluoride balance (equilibrium) will excrete fluoride at a level approximately equal to the water concentrations.

7.3.4 First Aid for Acute Toxic Exposure

Once fluoride poisoning has been established, first aid treatment should be started while waiting for medical help. Recommended first aid for ingested toxic fluoride overdose is given in Table 7-1.

The recommended first aid for air-borne fluorides (nose bleed) is as follows:

1. Move the victim from the exposed area;
2. Keep the victim quiet;
3. Place the victim in a sitting position, leaning forward, if possible; if that is not possible, place the victim in a reclining position with the head and shoulders raised;
4. Apply pressure directly by pressing the bleeding nostril toward the midline;
5. Apply cold compresses to the victim's nose and face;
6. If bleeding cannot be controlled by the preceding measures, insert a small, clean pad of gauze (not absorbent cotton) into one or both nostrils and apply pressure externally with the thumb and index finger; A free end of the pad must extend outside the nostril so that the pad can be removed later; and
7. If bleeding continues, obtain medical assistance.

The recommended first aid for an acid splash is as follows:

1. Wash away the chemical with large amounts of water as quickly as possible. Remove the victim's clothing from the affected areas and continue washing for at least 5 minutes;
2. Where skin damage has occurred, cover the burn with a dressing bandage and seek medical attention;
3. If the eye is involved, immediately begin to wash the eye, eyelid, and face. Hold the eyelid open and wash the eye for at least 15 minutes';
4. After a thorough washing, cover the eye with a clean, dry, protective dressing and hold bandage in place, then transport the victim to a doctor; and
5. All instances of eye injury require medical attention. Even seemingly minor eye injuries can leave the eye vulnerable to infections that can lead to blindness.

Keep in mind that fluorosilicic acid can be neutralized with sodium bicarbonate (baking soda). Thus, spills that can't be washed away can be neutralized.

TABLE 7-1

EMERGENCY TREATMENT FOR INGESTED FLUORIDE OVERDOSE

Milligrams fluoride ion	Treatment
Less than 5.0 mg/kg* (226 mg/100 lb)	<ol style="list-style-type: none"> 1. Give calcium orally (milk) to relieve gastro-intestinal symptoms. Observe for a few hours. (Note: A can of vaporated milk can be kept on hand for a long period of time.) 2. Induced vomiting not necessary.
Over 5.0 mg/kg	<ol style="list-style-type: none"> 1. Move the victim away from any contact with fluoride and keep him warm. 2. If victim is conscious, induce vomiting by rubbing back of the throat with a spoon or your finger; or use syrup of Ipecac. While vomiting, the patient should be placed facedown with the head lower than the body to prevent inhalation of vomitus. (For patients with depressed gag reflex caused by age (6 months old), Down's syndrome, or severe mental retardation, induced miting is ontraindicated and endotracheal intubation should be performed before gastric lavage.) 3. Give the victim a glass of milk or any source of soluble calcium. (5% calcium gluconate, or calcium lactate solution. 4. Take the victim to the hospital as quickly as possible.

*Average weight/age 1-2 years = 15 kg; 4-5 years = 20 kg; 6-8 years = 23 kg.

7.4 Emergency Procedures for Fluoride Overfeed

7.4.1 Introduction

When a community is fluoridating its drinking water, there is always a potential for overfeeding. Most overfeeds are of no serious consequence (but should be corrected). For example, if the optimal level of fluoride for a community is 1.0ppm, and an overfeed

resulted from 2.0ppm in the drinking water for several years, very mild fluorosis would appear in a few persons. Higher levels of fluoride for shorter periods can be accepted with no adverse effects. (See Table 7-2 below.) As stated previously, at a rural school in Seabrook, North Carolina, the fluoride level had been adjusted to seven times the optimal level for 12 years with no unacceptable fluorosis. Thus, the danger of overfeed, while always present, should not be over-emphasized.

7.4.2 Recommended Fluoride Overfeed Actions

**TABLE 7-2
RECOMMENDED ACTIONS FOR FLUORIDE OVERFEED**

IF THE FLUORIDE CONTENT (MG/L) IS:	THEN, PERFORM THE FOLLOWING RECOMMENDED ACTIONS:
.5 above optimum to 2.0	<ol style="list-style-type: none"> 1. Leave the fluoridation system on. 2. Determine what has malfunctioned and repair it.
2.0 to 4.0	<ol style="list-style-type: none"> 1. Leave the fluoridation system on. 2. Determine what has malfunctioned and repair it. 3. Notify your supervisor Name/phone / _____ / _____ and report the incident to the appropriate county or state agencies. Name/phone / _____ / _____
4.0 to 10.0	<ol style="list-style-type: none"> 1. Determine what has malfunctioned and immediately try to repair it. 2. If the problem is not found and corrected quickly, turn off the fluoridation system. 3. Notify your supervisor Name/phone _____ / _____ and report the incident to the appropriate county or state agencies, Name/phone _____ / _____ 4. Take water samples at several points in the distribution system and test the fluoride content. (Save the part of the water samples not used.) 5. Determine what has malfunctioned and repair it. Then, with supervisor's permission, restart the fluoridation system.
10.0 or higher	<ol style="list-style-type: none"> 1. Turn off the fluoridation system immediately. 2. Notify your supervisor Name/phone _____ / _____ and report the incident immediately to the appropriate county or state agencies. Name/phone _____ / _____ and follow their instructions.

IF THE FLUORIDE CONTENT (MG/L) IS:	THEN, PERFORM THE FOLLOWING RECOMMENDED ACTIONS:
	3. Take water samples at several points in the distribution system, and test the fluoride content. Save part of the sample for the state lab to test. 4. Determine what has malfunctioned and repair it. Then, with supervisor's permission, restart the fluoridation system.