

CHAPTER ONE

FLUORIDATION AND PUBLIC HEALTH

1.1 Definition of Water Fluoridation

Water fluoridation is the deliberate upward adjustment of the natural trace element, fluorine (in the ionic form of fluoride), using guidelines developed by scientific and medical research, for the purpose of promoting the public's health through the prevention of tooth decay. Fluoride is present in small but widely varying amounts in practically all soils, water supplies, plants, and animals, and thus is a normal constituent of all diets. The highest concentrations in mammals are found in the bones and teeth. All public water supplies in this country contain at least trace amounts of natural fluoride.

Few public health measures have been accorded greater clinical and laboratory research, epidemiologic study, clinical trial, and public attention-both favorable and adverse-than the fluoridation of public water supplies.

1.2 History

The discovery of the role of waterborne fluoride in preventing tooth decay is an interesting and intriguing story. One of the most brilliant investigations ever carried out in the epidemiology of chronic disease was the series of studies that led to demonstrating that fluoridated water had caries-inhibitory properties.

It started when a young dentist, Frederick S. McKay set up his practice in Colorado Springs, Colorado. He noticed that many of these patients' teeth exhibited a condition he called "Colorado Brown Stain." Since this wasn't described in any scientific literature, he was determined to find out more about it. In 1908, he initiated a study that led to the identification of the condition we now know as fluorosis (mottled enamel); this condition was prevalent throughout the surrounding El Paso County. Dr. McKay, along with another major figure in the dental world Dr. G. V. Black, wrote detailed descriptions of mottled enamel.

In the 1920's, Dr. McKay, along with others, concluded that something either in or missing from the drinking water was causing the mottled enamel. Also, in the late 1920's, Dr. McKay made another major discovery. Teeth with mottled enamel were essentially free of dental caries. In 1931, fluoride was identified as the element in drinking water that caused mottled enamel, but also inhibited dental caries.

In the 1930's, Dr. H. Trendley Dean, of the U.S. Public Health Service, and Dr. McKay collaborated to determine if fluoride could be added to the drinking water to prevent caries. Dr. Dean and other associates conducted several classic studies to establish a community fluorosis index.

This led to further studies that predicted the cause-and-effect relationship between fluoridation and the reduction of dental caries, and determined what the optimal fluoride levels should be for a community's drinking water. Dr. G. J. Cox, a dental researcher with the Mellon Institute in Pennsylvania, was the first person to propose adding fluoride to the drinking water for the prevention of dental caries.

The studies on fluorides were interrupted by World War II, but in 1945 and 1947, four classic studies were begun that finally proved the benefits of water fluoridation by adding fluoride to the drinking water of several communities. The most important study, under the direction of Dr. Dean, was started in 1945 in Grand Rapids, Michigan. (Fluoridation began in January 1945, in Grand Rapids; in May 1945, in Newburgh, New York; in June 1945, in Brantford, Ontario; and in February 1947, in Evanston, Illinois.) These studies firmly established fluoridation as a practical and effective public health measure that would prevent dental caries.

In the 1950's and 1960's, two more individuals emerged on the fluoridation scene. Although it had already been determined that fluoridation was safe and effective, the engineering aspects needed to be further developed and refined before more widespread community water fluoridation could be implemented. Franz J. Maier, a sanitary engineer, and Ervin Bellack, a chemist, both with the U.S. Public Health Service, made major contributions to the engineering aspects of water fluoridation.

Maier and Bellack helped determine which fluoride chemicals were the most practical to use in water fluoridation, the best mechanical equipment to use, and the best process controls. Bellack helped make major advances in testing for fluorides. In 1963, Maier published the first comprehensive book on the technical aspects of fluoridation: the "Manual of Water Fluoridation Practice." In 1972, Bellack, then with the U.S. Environmental Protection Agency, published the "Fluoridation Engineering Manual."

Over the past 40 years continuous studies have been conducted on fluorides and fluoridation by the U.S. Public Health Service, state health departments, and nongovernmental research organizations. Many very good reference books and booklets on fluoridation are available. Please write to the Centers for Disease Control and Prevention in Atlanta, Georgia or the American Dental Association in Chicago, Illinois, for additional information.

1.3 Health Effects of Water Fluoridation 1.3.1 General

The most positive health effect of water fluoridation is the prevention of tooth decay. The adverse health effect from high levels of fluoride in the drinking water is dental fluorosis. Controversy over fluoridation continues to exist and many charges have been leveled against it; these charges are discussed in a later section.

1.3.2 Benefits of Fluoridation

The highest rate of tooth decay activity is found in schoolchildren. It begins in early childhood, reaches a peak in adolescence, and diminishes during adulthood. At one time, nearly everyone in the United States was attacked by dental caries, the most prevalent chronic disease of man. It was truly universal. Prior to the widespread use of water fluoridation, almost 98 out of 100 Americans experienced some tooth decay by the time they reached adulthood.

Fluoride contributes substantial benefits in the prevention of tooth decay. Numerous studies, taken together, clearly establish a causal relationship between water fluoridation and the prevention of dental caries. While dental decay is reduced by fluoridated toothpastes and mouth-rinses, professional fluoride treatments, and fluoride dietary supplements, fluoridation of water is the most cost-effective method. It provides the greatest benefit to those who can least afford preventive and restorative dentistry and reduces dental disease, loss of teeth, time away from work or school, and anesthesia-related risks associated with dental treatment.

In the 1940s children in communities with fluoridated drinking water had reductions in caries of 20 to 40 percent over a lifetime, as compared to those living in non-fluoridated communities. Recent studies still reveal that caries are lower in naturally or adjusted fluoridated areas; however, the differences in caries between fluoridated and non-fluoridated areas are not as great as those observed in the 1940s. This apparent change is likely explained by the presence, in non-fluoridated areas, of fluoride in beverages, food, dental products, and dietary supplements.

Strong evidence now exists that water fluoridation not only makes the tooth more resistant to bacterial acids, but also actually inhibits the growth of certain kinds of bacteria that produce these acids. Also, it has now been shown that fluorides actually aid in the remineralization of the tooth, thus actually reversing the decay process after it already has begun.

Fluoridation thus enhances the appearance of the teeth, makes them more impervious to bacterial acids, and substantially reduces bills for restorative dentistry. For every dollar spent on water fluoridation, up to 50 dollars in dental bills may be saved. The cost of fluoridation is about 50 cents per person per year. The benefits of fluoridation can last for a life-time if one continues to consume fluoridated water.

1.3.3 Systemic and Topical Effects of Fluorides in Drinking Water

Generally, when water containing fluoride is drunk, a small amount is retained by fluids in the mouth and will be incorporated onto the tooth by surface uptake (topical effect). The other part of the fluoride utilized passes into the stomach and is rapidly absorbed by simple diffusion through the walls of the stomach and gut.

It enters the blood plasma and is rapidly distributed throughout the body, including the teeth (systemic effect). Because of the systemic effect, the fluoride ion is able to pass freely through all cell walls and thus is available to all organs and tissues for the body. Distributed in this fashion, the fluoride ion is available to all the skeletal structures of the body in which it may be retained and stored in proportions which, generally speaking increase with age and with intake.

The bones, teeth, and other parts of the skeleton tend to attract and retain fluoride. The soft tissues do not retain fluorides. It has been correctly stated that fluoride is a 'bone seeker. About 96 percent of the fluoride found in the body is deposited in the skeleton.

Since the teeth are part of the skeleton, the incorporation of fluoride into the teeth is basically similar to that in other bones. Incorporation of fluoride is most rapid during the time of the child's formation and growth. This time period is roughly from the 4th month of pregnancy to the 10th year. The 8th year probably marks the end of the maximum rate of incorporation of fluoride into the teeth. Erupted teeth differ from other parts of the skeleton in that once they are formed, with the exception of the dentin (inner part of the tooth) and the root, there is little cellular activity. Thus, there is not as much change in the fluoride levels in the teeth after they are formed. It is important that children drink the proper amount of fluoridated water during the early development of the permanent teeth, starting at birth.

As is true with bones, fluoride concentrated in the teeth has a direct relationship with the level of fluoride in the drinking water and with the age of the person. But, not being subject to internal repair by the body, the teeth do not tend to lose fluoride by re-absorption except in the root structure. The amount of fluoride in the teeth varies as widely as the fluoride in the other parts of the skeleton, from several hundred to several thousand parts per million (ppm).

Note that the fluoride incorporated in the tooth is in a soluble form. Insoluble fluorides, such as calcium fluoride (CaF_2) particulates, will pass through the body and will not be utilized. Also, fluorides in the organic form are not utilized by the body. The actual mechanism for the incorporation of the fluoride ion into the tooth and bones is not well known. But it is known that the fluoride ion replaces the hydroxyl ion (OH^-) in the crystal lattice in the enamel, resulting in a stronger tooth.

1.3.4 Dental Fluorosis

Dental fluorosis is defined as the whitish to brownish spots seen on teeth. It has been clearly established that high levels of fluoride in the drinking water will cause fluorosis (or "mottled enamel", as it is sometimes called). Dental fluorosis has been recognized since the turn of the century in people with high exposure to naturally occurring fluoride in drinking water. It has always been more prevalent in fluoridated than non-fluoridated areas. Dental fluorosis occurs only during tooth formation and becomes apparent upon eruption of the teeth.

It ranges from very mild symmetrical whitish areas on teeth (very mild dental fluorosis) to pitting of the enamel, frequently associated with brownish discoloration (severe dental fluorosis). The very mild form is barely detectable even by experienced dental personnel. Moderate and severe forms of dental fluorosis, considered by some investigators as presenting a cosmetic problem, do not appear to produce adverse dental health effects, such as the loss of tooth function, and represents less than six percent of the cases of fluorosis nationally.

In the 1940s, about 15 percent of the population displayed very mild and mild dental fluorosis when the concentration of fluoride found naturally in the drinking water was about 1 part per million (ppm) (see Figures 1-1 and 1-2 on page 5). Over the last 40 years, in areas where fluoride is added to the drinking water to bring the total level of fluoride to about 1ppm (optimally fluoridated areas), there may have been an increase in the total prevalence of dental fluorosis.

In fluoridated areas, there is clear evidence that the total prevalence of dental fluorosis has increased over the last 40 years.

The greater the fluoride exposure during tooth development; the greater the likelihood of dental fluorosis. In the 1940s and 1950s, the major sources of fluoride were from drinking water and food. Since then, numerous sources of fluoride have become available, including dental products containing fluoride (e.g., toothpastes and mouthrinses) and fluoride dietary supplements. The inappropriate use of these products can contribute significantly to total fluoride intake. Increases in the prevalence of dental fluorosis in a population should be taken as evidence that fluoride exposure is increasing. Because dental fluorosis does not compromise oral health or tooth function, an increase in dental fluorosis, by itself, is not as much of a dental public health concern as it is an indication that total fluoride exposure may be more than necessary to prevent tooth decay. Prudent public health practice generally dictates using no more of a substance than the amount necessary to achieve a desired effect.

1.3.5 Skeletal Fluorosis

Very high concentrations of fluoride in drinking water consumed for long periods of time have been found to cause skeletal fluorosis. Crippling skeletal fluorosis is an adverse health effect of the bone resulting from a fluoride intake of 20 mg/day over periods of 20 years or more. A drinking water fluoride concentration of 10 mg/L, given a 2 liters per day consumption rate, would correspond to this value. Crippling skeletal fluorosis, as well as rheumatic attack, pain, and stiffness, have been observed in individuals chronically exposed to fluoride in drinking water at levels of 10mg/L to 40 mg/L.

FIGURE 1-1
DEGREE OF MOTTLED ENAMEL AND FLUORIDE CONCENTRATION IN WATER

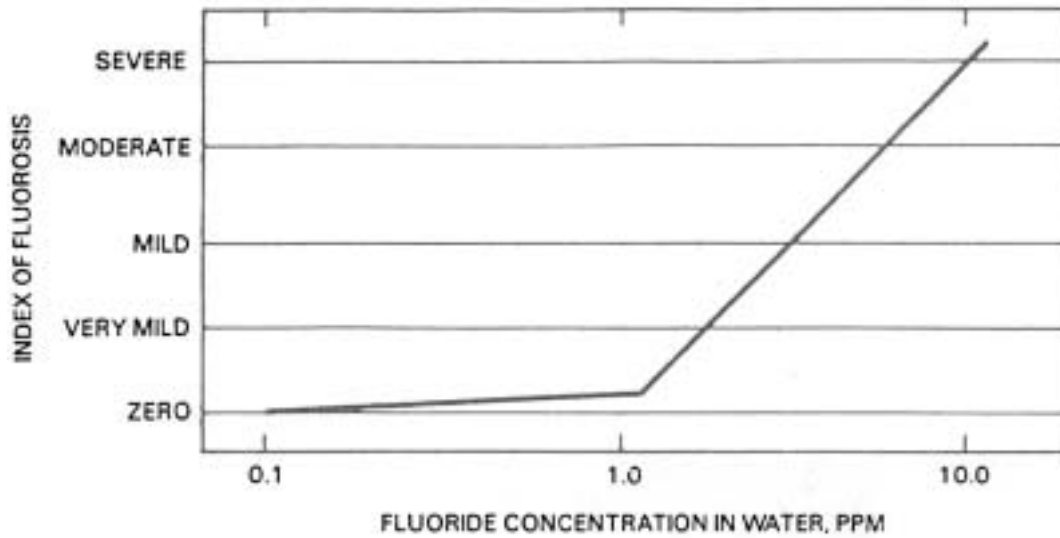
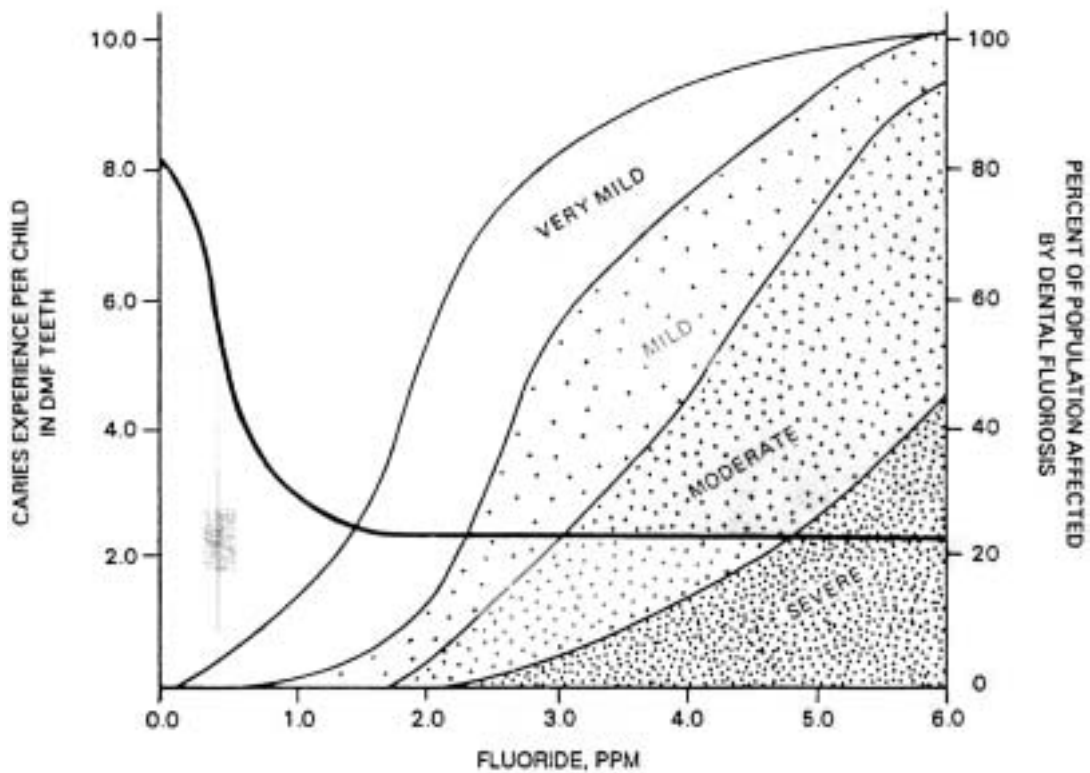


FIGURE 1-2
DENTAL CARIES AND DENTAL FLUOROSIS
IN RELATION TO FLUORIDE IN PUBLIC WATER SUPPLIES



1.3.6 Cancer

Accusations that fluoride causes cancer have existed since the 1940's. This still continues to cause controversy in some areas of the United States.

More than 50 human epidemiologic studies of the relationship between water fluoridation and cancer have been conducted. These studies usually attempt to identify statistical associations between cancer rates and county or city-wide patterns of water fluoridation. Expert panels, that reviewed this international body of literature agree that there is no credible evidence of an association between either natural fluoride or adjusted fluoride in drinking water and cancer in humans (IARC, 1982., Knox, 1985).

In March of 1990, the National Cancer Institute (NCI) updated and expanded an earlier analysis of cancer deaths, by county in the United States, to determine whether there is or is not an association between cancer and fluoride in drinking water. The new studies evaluated an additional 16 years of cancer mortality data, and also examined patterns of cancer incidence between 1973 and 1987 in the Surveillance, Epidemiology, and End Results (SEER) Program cancer registries. SEER, an NCI-sponsored network of population-based cancer incidence registries, started in 1973 and represents about 10 percent of the U.S. population. The SEER registries were used to obtain incidence data on all cancers, with special emphasis placed on trends in osteo-sarcoma. Because mortality data do not contain information on tumor-specific pathology, analysis of osteo-sarcomas is limited to the incidence data.

The NCI study identified no trends in cancer risk, which could be attributed to the introduction of fluoride into drinking water.

1.3.7 Bone Fractures

Findings from several epidemiologic studies suggest that the incidence of certain bone fractures may be greater in some communities with either naturally high or adjusted fluoride levels. However, there are a number of confounding factors that need resolution to determine whether or not an association exists. Additionally, other studies do not show an increase in the incidence of bone fractures', one study provided evidence of a lower incidence of bone fractures in an optimally fluoridated community as compared to a similar community with trace levels of fluoride in the water. While further research is required, there appears to be very little chance that fluoride would cause any increase in bone fractures.

1.4 Maximum Contaminant Levels

The U.S. Environmental Protection Agency (USEPA) has established regulatory limits on the fluoride content of drinking water. Based on a detailed review of health effects studies on fluoride, the USEPA set a primary maximum contaminant level (MCL) of 4 mg/L in water systems to prevent crippling skeletal fluorosis. The MCL of 4 mg/L, therefore, provides an adequate margin of safety.

A secondary maximum contaminant level of 2 mg/L has been established by USEPA as the level above which dental fluorosis is likely to occur. The state has the option of setting 2 mg/L as their MCL in that state. In fact, several states have done so.

1.5 Alternatives to Water Fluoridation

While there are other ways to provide the benefits of fluoride besides the fluoridation of municipal water supply systems, one point must be kept clearly in mind. Municipal water fluoridation is by far the most cost-effective and practical means available for reducing the incidence of caries in the community. This conclusion is based on the mass of evidence demonstrating the efficacy of the measure, and on the most current information on costs of implementing fluoridation. School fluoridation is another way to provide the benefits of water fluoridation, but should not be considered as an alternative to water fluoridation. This is because with both school fluoridation and community fluoridation, the fluoride level of the drinking water is being adjusted upward.

In general, there are live alternatives to water fluoridation which use either topical or systemic fluorides:

A. Topical Fluorides

1. Fluoride gels (professionally applied)
2. Fluoride mouthpieces
3. Fluoride dentifrices

B. Systemic Fluorides

1. Fluoride tablets
2. Fluoride drops

While topical fluorides can be used in conjunction with water fluoridation (optimally fluoridated water in community or school water systems or naturally fluoridated water), systemic fluorides should not. Utilization of only one type of systemic fluoride is sufficient to prevent tooth decay.

1.6 The Controversy

Although community water fluoridation has been proven to be the safest and the most cost-effective method to prevent dental caries, a small percentage of the population continues to oppose its introduction into community water systems. When fluoridation is being considered for adoption by a community, persons opposed to fluoridation often introduce charges or allegations that attempt to disprove the benefits, safety, and effectiveness of fluoridation. Many of these charges are addressed to the plant operator, utility manager, and consulting engineer. They are generally divided into two groups: engineering charges and medical/legal charges. Sample charges are presented below.

1. THE CHARGE: Natural fluoridation is different from adjusted fluoridation.

THE FACT: No matter where the fluoride ion comes from, the fluoride ion in drinking water is the same. The element fluorine is comprised of atoms with a definite structure.

When fluorine combines with another element, each fluorine atom gains one electron and the new substance is called fluoride. In a water solution, these fluoride particles tend to separate into charged particles called ions. Fluoride ions have unique properties that are different from fluorine and are consistent regardless of the origin of the fluoride ion.

2. THE CHARGE: Fluoridation is wasteful. Less than one tenth of one percent of the water is drunk by children. The remaining 99.9 percent is used for sanitary and industrial purposes, fighting fires, washing streets, sprinkling lawns, etc.

THE FACT. Fluoridation can be considered as wasteful based on this argument, but in a similar manner, chlorination and all other water treatment processes are also wasteful. Fluoridating the water consumed only by children is not possible, so fluorides must be added to the entire water supply.

Even with this admitted waste, the cost of this proven method of preventing tooth decay in children is small compared to the benefits received.

3. THE CHARGE: There is a danger that, either by accident or design, a whole town will be over-fluoridated resulting in a mass poisoning of the community.

THE FACT. In a properly designed and operated system, the apparatus, chemicals, and mode of operation are arranged so that the possibility of administering a dangerous dose to a whole community is remote. The type of feeding equipment commonly used is usually designed to add not more than 2 mg/L (twice the optimal level) when operating at maximum capacity. In addition, the fluoride content of the water is checked routinely, so that any deviation from the optimal level is immediately discovered.

The minimum fatal dose for a human (assumed weight of 150 lbs) is approximately 2gm of fluoride (as F⁻). To fluoridate 10 mil gal (32 ML) of water at 1mg/L would require 190lb (86 kg) of sodium fluoride or 140lb (64 kg) of sodium fluorosilicate. To raise the fluoride concentration to a level where the minimum fatal dose (2gm) could be consumed in a 10oz (300 ml) glass of water, it would be necessary to add to the same water supply approximately 700 tons (635,000 kg) of sodium fluoride or 500 tons (450,000 kg) of sodium fluorosilicate at one time. Although the danger would probably be greatest in larger systems using dry feeders, the hopper capacity of the fluoridator (dry feeder) should be designed to be limited to a two-day's supply (about 50lb [23kg]), and even if a one-week's supply was added at one time, it would only be about one five hundredth of the quantity required for the minimum fatal dose.

Under these circumstances, it would be impossible for 700tons (635,000 kg) of fluoride chemical to be put into the water at one time.

4. THE CHARGE: Fluoridation causes corrosion in the water lines.

THE FACT: Corrosion of potable water is related primarily to dissolved oxygen concentration, pH, water temperature, alkalinity, hardness, salt concentration, hydrogen sulfide content, and the presence of certain bacteria. The fluoride ion itself is unrelated to corrosion at concentrations at or near the optional level found in potable water. Under certain water-quality conditions, a small increase in the corrosivity of potable water that is already corrosive may be observed after treatment with alum, chlorine, fluorosilicic acid, or sodium fluorosilicate. This increase in corrosivity is caused by a depression of PH resulting from these treatments and occurs in potable water with a low buffering capacity. The increase in the corrosivity of potable water as a result of the addition of the fluorosilicic acid or sodium fluorosilicate is negligible for most water systems, but where it is significant, it can be reduced by adding small amounts of lime or caustic soda.

5. THE CHARGE: Fluoride adds taste, color, or odor to the water supply.

THE FACT: Taste, color, and odor are not affected by the addition of fluoride at a concentration of 1 mg/L. Water supplies normally vary in their taste, color, and odor. Materials other than fluoride, such as total dissolved solids and organic contaminants, are primarily responsible for these variations.

6. THE CHARGE: The hardness of the water makes the introduction of fluoride difficult.

THE FACT: Calcium and magnesium can reduce the solubility of fluorides, but the effect is negligible with the concentrations present in natural waters. Under certain conditions, softening of the water used to make a fluoride solution may be necessary to enable it to be added uniformly to the supply. For example, it may be necessary to soften the makeup water that is added to a fluoride saturator; but softening of an entire water supply is not necessary for the addition of fluoride chemicals.

7. THE CHARGE: Although fluoride may be added at a uniform rate at the source of the water supply, there is the likelihood that fluoride will form "pockets" in the water pipes, which would give rise to uneven concentrations.

THE FACT: At the concentration of 1 mg/l F⁻ fluoride is completely soluble and will not be precipitated out of solution, even in hard water. The concentration of fluoride at the plant tap will be carried throughout the distribution system. If, however, a change in the concentration occurs at the plant, there will be a time lag before the change reaches outlying parts of the distribution system.

The time lag depends on the length of pipe through which the water has to pass. "Pockets of fluoride" do not occur in the distribution systems.

8. THE CHARGE: There are alternative, inexpensive methods, such as home fluoridation units, that can be used by individuals who believe in the value of fluoridation.

THE FACT: There is no reasonable alternative to community fluoridation. It is impractical and expensive to attempt to equip each home with its own fluoridation system. The operation and maintenance problems are also difficult for the average homeowner to handle.

9. THE CHARGE: Fluoridation is promoted by the big chemical companies, who make huge profits from it.

THE FACT: Production and sale of fluoride chemicals for water fluoridation represents only a very small fraction of the business of the fluoride chemical industry. There are other industrial uses of fluoride chemicals, such as in the aluminum industry.

10. THE CHARGE: Fluoridation causes cancer.

THE FACT: Early in 1975, the National Health Federation issued information alleging a relationship between fluoridation and cancer. Their allegations have been repeatedly disproved, both by separate reviews of their work and by independent studies, not only in the United States, but in several other countries. Reviews have been conducted by the National Cancer Institute of the National Institutes of Health. In addition, independent studies conducted in the United States by the National Cancer Institute; the National Heart, Lung, and Blood Institute', and the Centers for Disease Control and Prevention (CDC) found no relationship between fluoridation and cancer death rates. After evaluation of the available studies on the oncogenicity of fluoride, USEPA concluded that adequate information does not exist to conclude that fluoride presents a cancer risk to humans. A recent study in Great Britain found nothing in any of the major classes of epidemiological evidence that could lead to the conclusion that either fluoride occurring naturally in water, or fluoride added to water supplies is capable of inducing cancer or of increasing mortality from cancer.

11. THE CHARGE: Fluoridation causes heart diseases, diabetes, and liver and kidney ailments.

THE FACT: Studies in 64 cities (32 of which have used naturally fluoridated water for generations and 32 of which had no fluoridation) show no significant difference in the mortality rates from these diseases. These findings have also been confirmed by studies in Illinois, New England, Texas, and New York.

12. THE CHARGE: Fluoridation is mass medication.

THE FACT: Fluoride is not a medicine. It does not treat or cure anything. It is a nutrient that prevents dental decay. Like other minerals in the diet, fluoride helps the body to resist disease, namely, dental decay.

13. THE CHARGE: Fluoridation is an unconstitutional and illegal invasion of individual rights.

THE FACT: Over the years, the legality of fluoridation has been tested repeatedly. Courts in more than 25 states have heard fluoridation cases, and the constitutionality of fluoridation has been upheld by Supreme Courts in more than a dozen states.

In addition, at least eight times, the U.S. Supreme Court has declined to hear these cases because no substantial federal constitutional question was involved.

The legality of fluoridation has been tested in the courts more often than any other public health measure. Beginning in 1952 injunctions were sought numerous times in order to prevent the initiation or continuance of fluoridation.

These cases were generally based on several of the following types of arguments: violation of religious freedom, violation of pure food arts, lack of or abuse of police power or some municipal authority, an unreasonable or unnecessary measure, wasteful or illegal use of public funds, and unsafe measure or nuisance, availability of alternatives, breach of contracts class legislation (only children benefit), and deprivation of fundamental liberties.

In all cases fluoridation has prevailed. During 30 years of litigation, fluoridation has which stood challenges under constitutional objectives (Amendments 1, 10, and 15), it has been upheld in the highest courts in more than a dozen states, and it has withstood legal challenges in more than 25 states.

14. THE CHARGE: Fluorides in drinking water can produce allergic reactions.

THE FACT: Fluoride, in the concentration recommended for dental health, does not cause such reactions. The American Academy of Allergy conducted a review of clinical reports of possible allergic responses to fluoride. The academy found no evidence of allergy or intolerance. Following completion of the study, the executive committee of the academy unanimously adopted the following statement; "There is no evidence of allergy or intolerance to fluorides as used in the fluoridation of community water supplies."

15. THE CHARGE: The cumulative effect of fluorides from a fluoridated water supply will permanently damage the tissues and bones of the body.

THE FACT: A minute part of the fluoride ingested is deposited in the bones and teeth, the remainder is rapidly excreted through the kidneys. Bones and teeth will accumulate fluoride over long periods of time. This is not a health problem, but rather a benefit when an optimal concentration is consumed. As discussed previously, adverse health effects may occur when a high concentration is consumed over an extended period of time.

16. THE CHARGE: Fluoride is used as rat poison and, therefore, is harmful to humans.

THE FACT: Although fluoride was used as a rat poison in the past, it was not very effective in reducing the population of rats and thus was slowly discontinued. At present, fluoride compounds are not used as a rodenticide. Large doses of fluoride are toxic to humans. It is essential to understand, however, that fluoride (as are many other inorganic chemicals) has a dual nature and is considered by many health authorities to be an essential nutrient in humans. Although serious toxic effects are possible from massive doses of extremely high levels of fluoride, trace amounts of fluorides in drinking water have a beneficial effect. The implication that fluorides in large doses and in trace amounts have the same effect is incorrect. Many chemical elements that are essential nutrients in humans are toxic in amounts larger than nutritional requirements, including magnesium, manganese, zinc, iodine, and iron.

The list of objections to fluoridation, whether they relate to engineering, medical, legal, or other questions, could go on indefinitely. As far as the water plant operator and the engineer are concerned, the addition of fluoride to a water supply is well within their province, and it is their duty to follow the directives of health officials and the governing body of the community in not just adding fluorides, but in doing the job right.

It is unfortunate that irrelevant, unreplicated, or refuted research is purposefully presented to the detriment of the public's health. It is also unfortunate that misinterpretation of actions in foreign countries and out-of-context statements continue to circulate and create unnecessary fears. For every report, which casts doubts about fluoridation, there are innumerable reports attesting to its safety and efficacy. It is not surprising that some differences of opinion among scientists and professionals in research and medicine may occur. What is surprising, however, is their almost universal agreement on the safety and effectiveness of fluoridation. Fluoridation is not a controversy in any scientific sense. There are few public health measures, which have had the scientific endorsement and broad base of research, which supports its use, as does fluoridation.

Community fluoridation is supported by government officials, the U.S. Public Health Service, the American Dental Association, the American Medical Association, the World Health Organization, the American Water Works Association, and virtually every scientific and professional organization in the health field. In the almost fifty years of fluoridation, there has never been any clinically substantiated evidence of harm to anyone from drinking optimally fluoridated water.

Some of the more common questions that may arise have been presented for the water treatment plant operator. There are several studies and reports on the charges against fluoridation that are very complete. If additional information is desired on any charge or information on a charge not covered in this manual, please refer to Fluoridation Facts, (a publication of the American Dental Association), or other similar publications; or contact your state regulatory agency for water supplies, the state department of health, or the Division of Oral Health in the Centers for Disease Control and Prevention, Atlanta, Ga.

1.7 Status of Water Fluoridation

As of 1989, fluoridation in the United States was being practiced in approximately 8,100 communities serving more than 126 million people. Residents of over 1,800 additional communities, serving more than 9 million people were consuming water that contains at least 0.7mg/L fluoride from natural sources.

One hundred cities with populations of 50,000 or more, including Washington, D.C., and Chicago, Illinois, have had adjusted fluoridation for more than 20 years. Approximately 70 percent of all cities with populations of 100,000 or more have fluoridated water. More than 22 states and the District of Columbia provide fluoridated water to more than half their population. Of the 50 largest cities in the United States (from the 1989 U.S. census), 42 are fluoridated. Of the 10 largest cities, only Los Angeles and San Diego, California, are not fluoridated. As of 1985, eight states (Connecticut, Georgia, Illinois, Minnesota, Nebraska, Ohio, Michigan, and South Dakota) have some type of mandatory fluoridation laws.

In 1990, approximately 38 countries reported that community water fluoridation is benefiting approximately 208 million people. The United States, Canada, Brazil, Australia, Venezuela, and Chile have large populations consuming fluoridated water. The city-states of Hong Kong and Singapore are totally fluoridated. Fluoridation has been seriously hindered in Europe by the opponents of fluoridation. In fact, there may be very little progress toward fluoridation in Europe in the foreseeable future.