* Drinking Water Fluoridation
Time for Another Look

Presented by
Preston Luitweiler, PE

at the
PA AWWA Annual Conference
Hershey, PA
Wednesday, April 22, 2015
• History of Drinking Water Fluoridation
• World, U.S. and PA Picture
• Early and Recent Science
• Risk
H. Trendley Dean published epidemiological studies suggesting that a fluoride level of about 1 mg/L was associated with fewer cavities.

*The Early “Science”*
• Grand Rapids, MI - beginning January 25, 1945
• Study results published in 1950 showed significant reduction of cavities

* Early Application
Illustration in a 1955 flier by the Keep America Committee, alleging that fluoridation was a Communist plot.
The World Perspective
Percentage of population receiving fluoridated water, including both artificial and natural fluoridation. [18]

- 80–100%
- 60–80%
- 40–60%
- 20–40%
- 1–20%
- < 1%
- unknown
Geographical areas associated with groundwater having over 1.5 mg/L of naturally occurring fluoride, which is above recommended levels. [10]
Naturally fluoridated ~ 1 mg/L
- Argentina
- France
- Gabon
- Libya
- Mexico
- Senegal
- Sri Lanka
- Tanzania
- U.S.
- Zimbabwe

Naturally fluoridated >> 1 mg/L
- Parts of Africa, including Zimbabwe
- China (~200 million people)
- India
- Parts of the U.S.

Fluoride added
- Argentina
- Australia
- Brazil
- Canada
- Chile
- Colombia
- Hong Kong
- Ireland
- Korea
- Malaysia
- New Zealand
- Phillipines
- Singapore
- Spain
- UK
- United States
- Vietnam

Fluoridation discontinued
- Finland
- Germany
- Japan
- Netherlands
- Sweden
- Israel
• Toothpaste, mouthwash
• Table Salt
  • Switzerland (65% - 70%)
  • Germany (65% - 70%)
  • Czech Republic (35%)
  • France (14%)
  • Spain (10%)
• Milk (powder - rural Chile)

* Alternatives to Drinking Water Fluoridation
• Fluoridated supplies (partial list)
  • Philadelphia
  • Chester Water Authority
  • Pittsburgh
  • State College

• Non-Fluoridated supplies (partial list)
  • Most of Bucks, Montgomery, Chester and Delaware counties
  • Most small systems across PA
  • Private wells

*PA Picture
• Federal Drinking Water MCL of 4 mg/L
• Federal SMCL of 2 mg/L - exceedance requires public notification (much like exceedance of half the MCL for nitrate or arsenic)
• Federal recommended target fluoride level reduced from 1.0 mg/L to 0.7 mg/L in 2011
• State by state - wide variation
• Ohio - Required - level set in state law
• Illinois - Required - level set in IDH regulations implemented by IEPA
• Utah - Discourages fluoridation
• Pennsylvania - Not required; when implemented, Chapter 109 regulations apply; in PA the MCL is the same as the Federal SMCL (2 mg/L)
Occurrence of dental carries

Systematic Review of water fluoridation - British Medical Journal (BMJ), October, 2000

*“Science” 2000
What this study added

• The quality of the evidence is low

• Overall, reductions in the incidence of caries were found, but they were smaller than previously reported

• The prevalence of fluorosis (mottled teeth) is highly associated with the concentration of fluoride in drinking water

• An association of water fluoride with other adverse effects was not found
Fig 1 Change in proportion (%) of children without caries in fluoridated compared with non-fluoridated areas (mean difference and 95% confidence interval)
Fig 2 Change in decayed, missing, and filled teeth for primary/permanent teeth (mean difference and 95% confidence interval)
Dental Fluorosis

Occurrence of dental fluorosis is significantly higher in communities supplied by fluoridated tap water

*“Science” 2000
Fig 3  Proportion of population with dental fluorosis by water fluoride concentration with 95% confidence interval for proportion. Fluoride concentration is plotted on log scale because of linear association between this and log (odds) of fluorosis. Each circle represents a study area in which the proportion of people with fluorosis is estimated—the larger the circle, the higher the precision of the estimate.
Fig 4 Proportion of population with fluorosis of aesthetic concern by water fluoride concentration (plotted on untransformed scale because of linear association between this and log (odds) of "aesthetic fluorosis"). Each circle represents a study area in which the proportion of people with fluorosis is estimated—the larger the circle, the higher the precision of the estimate.
• Fluoridated toothpastes and mouthwash
• Improved dental hygiene and dental care
• More fluoride in food products

*What has changed since 1950?
• The beneficial effects of fluoride in reducing dental carries arise from topical application (toothpaste; saliva)
• Benefits of fluoride in tap water apply mostly to a small segment of the population (children ages 3 to 16 years old)
• The negative effects of dental fluorosis arise from ingestion of fluoride (from all sources at all ages)
<table>
<thead>
<tr>
<th>Age</th>
<th>&lt;0.3 ppm F</th>
<th>0.3 to 0.6 ppm F</th>
<th>&gt;0.6 ppm F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth to 6 months</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 mo to 3 years</td>
<td>0.25 mg</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3 to 6 years</td>
<td>0.50 mg</td>
<td>0.25 mg</td>
<td>0</td>
</tr>
<tr>
<td>6 to at least 16 years</td>
<td>1.00 mg</td>
<td>0.50 mg</td>
<td>0</td>
</tr>
</tbody>
</table>
• Some studies have shown a negative correlation between IQ and level of fluoride in tap water
• Fluoride is a developmental neurotoxin
• Other adverse health affects have been suggested (but not proven)
• Why fluoridate tap water today?
• How sure are we of the benefits?
• How can we control dose?
  • Fluoride levels in bottled water can vary widely, and there is no requirement to disclose level
  • There are other sources of fluoride (toothpaste, food)
• How sure are we that benefits outweigh risks?
What are the risks

• To public water supply customers?
• To workers?
• To the general public?
• The occurrence of dental fluorosis increases in populations receiving fluoridated tap water
• Infants should not be given fluoridated water; infant formula should not be made with fluoridated tap water
• Accidental overfeed of fluoride chemical can be harmful, even fatal.

*Risks to public water supply customers*
• The occurrence of dental fluorosis increases in populations receiving fluoridated tap water

• Infants should not be given fluoridated water; infant formula should not be made with fluoridated tap water

• Accidental overfeed of fluoride chemical can be harmful, even fatal.
"Your public water supply is fluoridated. Recent studies have discovered the possibility that infants less than 12 months old may be consuming too much fluoride, increasing their risk of dental fluorosis. Parents and caregivers can reduce this risk by using water that has very low fluoride levels or is fluoride free when mixing with liquid concentrate or powdered infant formula. Consult your healthcare provider for more information"
• The occurrence of dental fluorosis increases in populations receiving fluoridated tap water
• Infants should not be given fluoridated water; infant formula should not be made with fluoridated tap water
• Accidental overfeed of fluoride chemical can be harmful, even fatal.

* Risks to public water supply customers
<table>
<thead>
<tr>
<th>Incident Date</th>
<th>City, State (County)</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/24/03</td>
<td>Marlboro, MA (Essex)</td>
<td>Millham Treatment Plant</td>
<td>Valve malfunction -- fluoride level to 24 ppm</td>
</tr>
<tr>
<td>6/4/02</td>
<td>Dublin, CA (Alameda)</td>
<td>Public Water</td>
<td>23 employees of Humphrey Systems Inc. feel ill after using water fountains. Tests at Humphrey Systems on Tuesday showed concentrations of up to 200 milligrams per liter.</td>
</tr>
<tr>
<td>7/28/00</td>
<td>Wakefield, MA (Middlesex)</td>
<td>Wakefield Public Works</td>
<td>Water system overdosed with fluoride - people were exposed to 23 ppm</td>
</tr>
<tr>
<td>Nov-93</td>
<td>Middletown, MD</td>
<td>Middletown Water Distribution</td>
<td>Chemical overfeed -- fluoride level to 70 ppm. Citizens informed by radio not to drink or cook with the water</td>
</tr>
<tr>
<td>Aug-93</td>
<td>Poplarville, MS (Pearl River)</td>
<td>Public Water</td>
<td>40 persons poisoned; 15 sought treatment at hospital. Pizza Inn manager was the first to notify city officials after several customers became ill.</td>
</tr>
<tr>
<td>7/16/93</td>
<td>Chicago, IL</td>
<td>Public Water</td>
<td>Three dialysis patients died and five experienced toxic reactions to the fluoridated water used in the treatment process.</td>
</tr>
<tr>
<td>May-93</td>
<td>Kodiak, AK</td>
<td>Public Water</td>
<td>Possible chemical overfeed -- fluoride level to 22-24 ppm of fluoride in a sample.</td>
</tr>
<tr>
<td>Jan-93</td>
<td>Sarnia, ON Canada</td>
<td>Public Water</td>
<td>Chemical overfeed -- computer-controlled system had failed to shut down.</td>
</tr>
<tr>
<td>Jun-92</td>
<td>Danvers, IL (McLean)</td>
<td>Public Water</td>
<td>Chloride pump malfunctioned. City flushed the contaminated water through fire hydrants.</td>
</tr>
<tr>
<td>May-92</td>
<td>Hooper Bay, AK (Wade Hampton)</td>
<td>Yukon-Kuskokwim Health Corporation</td>
<td>Poor equipment and lack of a qualified operator. One death, 260 poisoned; one airlifted to hospital in critical condition.</td>
</tr>
</tbody>
</table>
| Feb-92       | Rice Lake, WI (Barron) | Public Water | Winds caused electrical failure; anti-siphon valve failed; chemical overfeed for two days. Residents vomiting, levels thought to have reached 20 ppm. Wisconsin State Dental Director: "To be harmful, exposure would have to have been about 225 ppm."

| Jul-91       | Portage, MI (Kalamazoo) | Public Water | Fluoride injector pump failed -- Fluoride levels reached 92 ppm; approximately 40 children developing abdominal pains, sickness, vomiting, and diarrhea. |
| Mar-86       | New Haven / North Branford, CT (New Haven) | Public Water | Chemical overfeed -- fluoride levels to 51 ppm. 18% of customers had acute health effects. Connecticut State Dental Director chastised water department personnel for not recognizing immediately that complaints were due to fluoride and not copper. |
| 10/6/81      | Jonesboro, ME (Washington) | Jonesboro Elem. School | Equipment failure -- fluoride levels to ~46 ppm; 57 people taken to hospital; 38 treated; two admitted. Patients experienced nausea, abdominal pain, and vomiting. On December 1, 1981, Jonesboro citizens voted 43-2 not to reinstate fluoridation at the school, and to charge the Dept. of Human Services with the emergency room bill of $1,137.24. [Diffuser broke, emptying a drum of fluoride chemical into the water supply (est. 10 ppm level). Customers were without potable water during a "water emergency" declared from 2:00 p.m. until 11:00 p.m. ] |
| 8/10/81      | Potsdam, NY (St Lawrence) | Public Water | Chemical overfeed -- fluoride levels to 1041 ppm, poisoning 22 individuals attending a farmers market hosted at the school. |
| 8/30/80      | Vermont | Public Water | Valve at water plant left open all night; est. 1000 gal chemical lost. One patient died and eight became ill after renal dialysis treatment. The fluoride level later found to be 35 ppm. |
Accidental release of fluoride chemicals can be harmful – to workers, property, the public and the environment.
<table>
<thead>
<tr>
<th>Incident Date</th>
<th>City, State (County)</th>
<th>Suspected Responsible Company</th>
<th>Incident Type</th>
<th>Medium</th>
<th>Gallons/LBS</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2/04</td>
<td>Memphis, TN</td>
<td>Memphis Light Gas and Water</td>
<td>Severed Line</td>
<td>Storm Drain</td>
<td>1000 gal</td>
<td>A third party contractor accidentally cut a product line, leaking 1000 gallons of fluorosilicic acid into a storm drain.</td>
</tr>
<tr>
<td>10/23/02</td>
<td>Gaffney, SC (Cherokee)</td>
<td>Gaffney Board of Public Works</td>
<td>Storage Tank</td>
<td>Water Sewer</td>
<td>3000 gal</td>
<td>Ruptured seam in storage tank.</td>
</tr>
<tr>
<td>7/28/02</td>
<td>Harrison Twp, MI (Macomb)</td>
<td>Public Water Company</td>
<td>Equipment failure</td>
<td>Land / Soil</td>
<td>3000 gal</td>
<td>Pump seal failed at the Mt. Clemens Water Filtration Plant. Storage tank (capacity: 6000 with 3400 in tank at time of accident) failed due to an external leak.</td>
</tr>
<tr>
<td>6/29/01</td>
<td>Gary, IN (Lake Fort Wayne, IN (COUNTY) )</td>
<td>Three Rivers Water Filtration Plant</td>
<td>Equipment malfunction</td>
<td>Sewer</td>
<td>6000 gal</td>
<td>Tank overflow spills acid into sewer, 4 employees treated after exposure to fumes. The material was released from a storage tank (capacity: 2500) due to a leak in the bottom of the tank while unloading a tanker truck (capacity: 12,500, had 2200 at time of accident) connected to the the wrong tank and two chemicals reacted caused an explosion. 45 employees evacuated.</td>
</tr>
<tr>
<td>2/20/01</td>
<td>West Memphis, AR (Crittenden)</td>
<td>Charleston Commissioners of Public Works</td>
<td>Storage Tank / Tank / Pavement</td>
<td>Land / Soil</td>
<td>2300 gal</td>
<td>Secondary containment lines were damaged causing the release</td>
</tr>
<tr>
<td>12/25/99</td>
<td>Portage, IN (Porter)</td>
<td>Chicago City Dept</td>
<td>Fixed</td>
<td>Land / Soil</td>
<td>98 gal</td>
<td>Storm Drain To Short Creek. Storage tank / flange bolt failed due to corrosion / Storage tank was not DOT regulated.</td>
</tr>
<tr>
<td>12/21/99</td>
<td>Chicago, IL (Cook)</td>
<td>City of Northfield</td>
<td>Fixed</td>
<td>Land / Soil</td>
<td>98 gal</td>
<td>Storm Drain To Short Creek. Storage tank / flange bolt failed due to corrosion / Storage tank was not DOT regulated.</td>
</tr>
<tr>
<td>8/9/99</td>
<td>Norfield, MN (Rice Albertville, AL (Marshall) )</td>
<td>Albertville Water Treat</td>
<td>Fixed</td>
<td>Land / Soil</td>
<td>98 gal</td>
<td>Storm Drain To Short Creek. Storage tank / flange bolt failed due to corrosion / Storage tank was not DOT regulated.</td>
</tr>
<tr>
<td>8/15/97</td>
<td>Greenville, SC (Greenville)</td>
<td>Greenville Water System</td>
<td>Fixed</td>
<td>Land / Soil</td>
<td>1500 gal</td>
<td>Storm Drain To Short Creek. Storage tank / flange bolt failed due to corrosion / Storage tank was not DOT regulated.</td>
</tr>
<tr>
<td>8/8/97</td>
<td>KiSSImMee, FL (Osceola)</td>
<td>City of Kissimmee</td>
<td>Fixed</td>
<td>Land / Soil</td>
<td>1000 gal</td>
<td>Storage tank / overflowed due to failure of the auto shut off.</td>
</tr>
<tr>
<td>7/29/95</td>
<td>Pittsburgh, PA (Allegheny)</td>
<td>City Water Treatment Plan</td>
<td>Fixed</td>
<td>Water</td>
<td>5000-7000 gal</td>
<td>All spilled into Allegheny River. Storage tank (capacity: 10,500 gal) / Crack alongside of plexiglass tank.</td>
</tr>
<tr>
<td>7/29/95</td>
<td>Fayetteville, NC (Cumberland)</td>
<td>Public Works</td>
<td>Fixed</td>
<td>Land / Concrete</td>
<td>300 gal</td>
<td>Storage tank / a valve was left open by operator.</td>
</tr>
<tr>
<td>7/29/95</td>
<td>Knoxville, TN (Knox Charlestonville, VA (Albemarle) )</td>
<td>KnOxville Utilities Board</td>
<td>Fixed</td>
<td>Land / Concrete</td>
<td>300 gal</td>
<td>300 gal storage tank/hose from drum pump on tank drained material out of tank.</td>
</tr>
<tr>
<td>8/31/93</td>
<td>Rizanna Water &amp; Sewer</td>
<td>Fixed</td>
<td>Land / Soil</td>
<td>1839 gal</td>
<td>Storage tank / line from the tank failed causing the release.</td>
<td></td>
</tr>
</tbody>
</table>
Impact on Public Notification
## MSDS Sheet

### SECTION 1  PRODUCT AND COMPANY IDENTIFICATION

<table>
<thead>
<tr>
<th>TRADE NAME:</th>
<th>Hydrofluoric Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEMICAL NAME:</td>
<td>Hydrofluoric Acid</td>
</tr>
<tr>
<td>CAS NUMBER:</td>
<td>10961-83-4</td>
</tr>
<tr>
<td>CHEMICAL FAMILY:</td>
<td>Inorganic Fluorides</td>
</tr>
<tr>
<td>SYNONYMS:</td>
<td>Fluorosilicic Acid, Hexafluorosilicic Acid, HFS, FSA</td>
</tr>
<tr>
<td>PRIMARY USE:</td>
<td>Industrial Chemical</td>
</tr>
</tbody>
</table>

### COMPANY INFORMATION:

- The Mosaic Company
- Area Corporate Center
- Suite 8400
- 3000 Campus Drive
- Plymouth, MN 55441
- www.mosaic.com

For non-emergency questions, phone numbers are 8 AM to 5 PM Central Time US:
- 855-918-8270 or 763-577-2720

### EMERGENCY OVERVIEW:

#### EMERGENCY TELEPHONE:
- 24 Hour Emergency Telephone Number:
- For Chemical Emergencies:
  - Spill, Leak, Fire, or Accident
  - Call CHEMTREC (800) 424-9300
  - North America: (800) 436-9300
  - Others: (703) 527-3827 (collect)

### SECTIONS

#### SECTION 2  HAZARD IDENTIFICATION

<table>
<thead>
<tr>
<th>EMERGENCY OVERVIEW</th>
<th>Health Hazards: Corrosive to the skin, eyes and mucous membranes through direct contact. Inhalation or ingestion. May cause severe irritation and burns, which may not be immediately apparent. Handle with extreme care.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical Hazards: Not applicable</td>
</tr>
<tr>
<td></td>
<td>Physical Form: Liquid</td>
</tr>
<tr>
<td></td>
<td>Appearance: Water white to straw yellow liquid</td>
</tr>
<tr>
<td></td>
<td>Odor: Pungent</td>
</tr>
</tbody>
</table>

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### NFPA HAZARD CLASS

<table>
<thead>
<tr>
<th>Health</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammability</td>
<td>0</td>
</tr>
<tr>
<td>Reactivity</td>
<td>1</td>
</tr>
<tr>
<td>Special Hazard</td>
<td>Corrosive</td>
</tr>
</tbody>
</table>

### NFPA RNC: Section 8

<table>
<thead>
<tr>
<th>Health</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammability</td>
<td>0</td>
</tr>
<tr>
<td>Reactivity</td>
<td>1</td>
</tr>
<tr>
<td>Physical Hazard</td>
<td>II</td>
</tr>
<tr>
<td>Special Hazard</td>
<td>Corrosive</td>
</tr>
</tbody>
</table>

### HAZARD IDENTIFICATION

#### POTENTIAL HEALTH EFFECTS:

- **Eye:** Corrosive. Contact may cause severe irritation, eye burns, and permanent eye damage.
- **Skin:** Corrosive. Contact may cause severe irritation; skin burns, and permanent skin damage.
- **Inhalation (Breathing):** Corrosive. Harmful if inhaled. May cause severe irritation and burns of the nose, throat, and respiratory tract.
- **Ingestion (Swallowing):** Corrosive. Harmful or fatal if swallowed. May cause severe irritation and burns of the mouth, throat, and digestive tract.
- **Signs and Symptoms:** Effects of overexposure may include severe irritation and burns of the mouth, nose, throat, respiratory and digestive tract. Symptoms of overexposure may include irritation of the nose and throat, coughing, salivation, headache, fatigue, dizziness, nausea, shock, and pulmonary edema (accumulation of fluid around the lungs). May lead to coma or death. Onset of symptoms may be delayed.
- **Cancer:** The ingredient(s) of this product are (are) not classified as carcinogenic by NTP, IARC, or OSHA.
- **Target Organs:** No data available for this material (see Other Comments below).
- **Developmental:** No data available for this material.
Fluorosilicic Acid
(Hydrofluorosilicic Acid, HFS, FSA)
Technical Data Sheet

<table>
<thead>
<tr>
<th>CHEMICAL ANALYSIS</th>
<th>SPECIFICATION</th>
<th>TYPICAL ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂SiF₆₆₆₆ %</td>
<td>23-25</td>
<td>23.5</td>
</tr>
<tr>
<td>Heavy Metals (as Pb), %</td>
<td>1.0 max</td>
<td>&lt; 0.02</td>
</tr>
<tr>
<td>H₂O, %</td>
<td>100 max</td>
<td>&lt; 20</td>
</tr>
<tr>
<td>P₂O₅, %</td>
<td>&lt; 0.2</td>
<td></td>
</tr>
</tbody>
</table>

Product meets ANSI/AWWA Standard B703-06, and is certified by NSF International or Classified by UL to ANSI/NSF Standard 60. Maximum use level for potable water treatment is 6.0 mg/L.

PHYSICAL PROPERTIES

Physical Description
Aqueous solution, water white to straw-yellow, corrosive acid, irritating to skin and having pungent odor.

Molecular Weight
1.212

Specific Gravity 23% solution @ 75°F
22°F (Decomposes)

Boiling Point of Aqueous 23% Solution
5°F (approx.)

Freezing Point of Aqueous 23% Solution
-4°F

Freezing Point of Aqueous 25% Solution
1.2

CONTAINERS

Tank truck, rubber or plastic-lined
40,000 lb (approx.)

Tank car, rubber or plastic-lined
196,000 lb net (approx.)

DOT AND FREIGHT DESCRIPTION

Hazardous Material Description
Fluorosilic acid
8, UN 1778, PG II

Haz. Mat. Class, I.D., Packaging Group
Hydrofluorosilicic Acid
16961-83-4

Freight Classification
None

Principal CAS Number
Corrosive

RQ
None

Placard
Corrosive

Label

Product meets ANSI/AWWA Standard B703-06, and is certified by NSF International or Classified by UL to ANSI/NSF Standard 60. Maximum use level for potable water treatment is 6.0 mg/L.
• Carefully consider the potential risks and costs before considering adding fluoride
• Thoughtfully evaluate the available and emerging science
• Closely monitor legislation that is periodically proposed in PA to mandate fluoridation
• Communicate with your customers and public health officials

*If your utility does not fluoridate*
• Carefully consider ongoing risks and costs
• Be sure every possible measure is in place to prevent occurrence of overfeed, worker exposure, or accidental release of chemical
• Monitor available and emerging science
• Consider discontinuing fluoridation
• Communicate with your customers and public health officials

*If your utility does fluoridate