Water Fluoridation: A Public Health Success Story

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This findings and conclusions in this presentation are those of the author and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
The Water Fluoridation Nexus
A State Fluoridation Program promotes Quality Assurance

Where the Rubber Hits The Road

• There is no Federal regulatory fluoridation program for PWS
• Increased potential for unwanted severe fluorosis close to 0.7 m/L
• Benefits are lost as level drops below recommended
• Promotion of oral health benefits normally required to encourage a community to fluoridate
State Programs Organize elements of the puzzle to enhance implementation and effectiveness

- Socio-Political
- Technical Engineering
- Water Fluoridation Practice
- Organizational Management
- Health Science
## Standards History

### Recommended

- **1945 - 1.0 mg/L**  
  Dental research consensus

- **1962 - 0.7 to 1.2 mg/L**  
  US PHS Standards  
  Annual temperature range  
<table>
<thead>
<tr>
<th>Lower</th>
<th>Optimal</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>0.7</td>
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<td>0.8</td>
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<tr>
<td>0.7</td>
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<tr>
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</tr>
<tr>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>

- **1995 - 0.7 to 1.2 mg/L**  
  CDC EAWRF Guidance  
  Annual temperature range  
<table>
<thead>
<tr>
<th>Lower</th>
<th>Optimal</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.7</td>
<td>0.8</td>
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<tr>
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<td>1.2</td>
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<tr>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
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<tr>
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<td>1.0</td>
<td>1.1</td>
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<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>1.0</td>
<td>1.1</td>
<td>1.5</td>
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</table>

### Regulatory Level

- **1977 - 1.4 to 2.4 mg/L**  
  EPA Interim Standards  
  Annual temperature range  
<table>
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<th>Upper</th>
<th>Limit</th>
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<td>0.8</td>
<td>1.4</td>
</tr>
<tr>
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<td>0.8</td>
<td>0.9</td>
<td>1.6</td>
</tr>
<tr>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>0.9</td>
<td>1.0</td>
<td>1.2</td>
<td>2.0</td>
</tr>
<tr>
<td>1.0</td>
<td>1.1</td>
<td>1.3</td>
<td>2.2</td>
</tr>
<tr>
<td>1.1</td>
<td>1.2</td>
<td>1.7</td>
<td>2.4</td>
</tr>
</tbody>
</table>

- **1986 – 4 mg/L MCL**  
  EPA Primary Standards  
  | 2 mg/L SMCL |
  | 4 mg/L MCLG |

- **2011 – in review**  
  Risk Assessment  
  Relative Source Contribution
National Primary Drinking Water Regulations

**MCLG** > **MCL** > **SMCL**

- **MCLG** - *Maximum Contaminant Level Goal*
  - Level at which anticipated adverse health effects would not be expected
  - Non-enforceable health-based goal
  - For Fluoride - 4.0 mg/L
National Primary Drinking Water Regulations

**MCLG > MCL > SMCL**

- **MCL** - Maximum Contaminant Level
  - The maximum permissible level of a contaminant
  - Economically and technologically feasible
  - For Fluoride - MCL - 4.0 mg/L
  - States can set stricter standards: CA, FL, NY
National Secondary Drinking Water Regulations

MCLG > MCL > SMCL

- SMCL – Secondary Maximum Contaminant Level

Aesthetic or cosmetic qualities of water
- Not enforceable: exceedance prompts public notification; intended as guidance
- For Fluoride - 2.0 mg/L
- EPA website indicates that this was promulgated for naturally high fluoride waters
National Secondary Drinking Water Regulations

• 2011 EPA assessments released
  – Relative Source Contribution
  – Risk Assessment

• Currently working on 6 year update which may provide timeline. Originally due in 2014, may be released in 2016 as a result of a large backlog coupled with reduced staff resources
Key Messages: Drinking Water Professionals

• Water fluoridation prevents up to 25% of tooth decay even with other fluoride sources
• Each dollar spent on CWF saves at least $43.
• Recommended level is safe and is below maximum regulatory levels allowed under SDWA.
• NSF/ANSI Standard 60 and AWWA Standards ensure quality products and protect the public.
Water operators as influencers

- Are knowledgeable about health issues revolving about water and are respected in their communities
- Need to actively engage water facility operators with education and resources on health benefits and safety
- Engagement and education is by the State program and other stakeholders
Water Risk Communication

• Fluoridation not unique, but part of broader concern about “purity” of water rather than “safety”

• Many utilities struggle with public concern about water quality and are a partner or resource

• When introducing a substance into the water, focus on safer/healthier benefits

• Water issues are volatile and “neutrals” are an audience subject to being alarmed, so be ready to educate the audience on the important issues
Will challenges settle down?

- Uncertainty in recent years increased opponents boldness: recommended level addresses those concerns
- AWWA MOP* 4 Editorial revision
- ADA Fluoridation Facts updating
- Hard to convince some people that oral health matters

* American Water Works Association Manual of Practice
It is possible that you will never be able to convince some people.

Dilbert by Scott Adams, 9/26/2013
Non-traditional communication channels increase the challenge

Percentage of U.S. adults who get news from nontraditional news sources

- 30% from Facebook
- 10% from YouTube
- 8% from Twitter
- 12% other social media sites

Source: PEW Research Center’s Journalism Project in collaboration with John S. and James L. Knight Foundation, March 2014
DOH has promotional materials
• www.cdc.gov/fluoridation, then click “Materials”

MEET JOHN & JOE. YOU DON’T KNOW THEM, BUT YOU’VE BEEN PROTECTING THEM FOR YEARS.

THANK YOU.

For 70 years, you have helped people in the United States improve their dental health by adding fluoride to community drinking water.

**Prevent Cavities:**
Water with fluoride reduces cavities by about 25 percent over a person’s lifetime.

**Benefit the Community:**
Community water fluoridation is safe, helps everyone have stronger teeth, and saves money in dental treatment costs.

Thank you for providing this valuable service. 70 years and still going strong.

For more information visit cdc.gov/fluoridation/engineering
CDC Support Statement

- Ready for use by States and Communities supporting the use of fluoride.
- Locate it by going to CDC’s fluoridation home page
  
  [www.cdc.gov/fluoridation/materials](http://www.cdc.gov/fluoridation/materials)

(we are currently reorganizing website and location might change)
EARWF* v2 in progress....

- Stakeholder comments: AWWA
- Administrative elements re-focused on state practices and experiences
- Engineering controls cross-checked with 10-State Standards
- Overfeed recommendation will be enhanced
- Operating tolerance guidance

*Engineering and Administrative Recommendations for Water Fluoridation
Operational Tolerance Range

- Maintaining fluoride in drinking water consistently close to the recommended concentration of 0.7 mg/L is important for caries prevention.
- Examined data for fluoride concentration from WFRS and consulted with AWWA on feasible operating ranges
- Preparing manuscript for submission to a peer-reviewed scientific journal
Percentage of PWS that Maintained Average Fluoride Concentration (AFC) within Selected Control Ranges (CR) around Target Fluoride Concentration (TFC)

<table>
<thead>
<tr>
<th>Control range</th>
<th>60 months</th>
<th>≥57 months</th>
<th>≥54 months</th>
<th>≥48 months</th>
<th>≥45 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>State established</td>
<td>43%</td>
<td>70%</td>
<td>79%</td>
<td>87%</td>
<td>90%</td>
</tr>
<tr>
<td>Lower limit</td>
<td>Upper limit</td>
<td>32%</td>
<td>56%</td>
<td>67%</td>
<td>80%</td>
</tr>
<tr>
<td>TFC - 0.1</td>
<td>TFC + 0.5</td>
<td>53%</td>
<td>76%</td>
<td>85%</td>
<td>92%</td>
</tr>
<tr>
<td>TFC - 0.2</td>
<td>TFC + 0.2</td>
<td>34%</td>
<td>60%</td>
<td>71%</td>
<td>82%</td>
</tr>
<tr>
<td>TFC - 0.15</td>
<td>TFC + 0.15</td>
<td>16%</td>
<td>39%</td>
<td>49%</td>
<td>66%</td>
</tr>
<tr>
<td>TFC - 0.1</td>
<td>TFC + 0.1</td>
<td>9%</td>
<td>23%</td>
<td>32%</td>
<td>51%</td>
</tr>
</tbody>
</table>

* The analysis included 988 public water systems with data for average fluoride concentration for all 60 months of 2006-2010 in the Water Fluoridation Reporting System.
Fluoridation Additives

- NSF Standard 60 Approved products
  - Fluorosilicic acid ........... 81% liquid
  - Sodium fluorosilicate .... 13% salt
  - Sodium fluoride .......... 7% salt
Fluoride added as solutions

- Fluorosilicic acid is an added liquid
- Sodium fluoride is a salt added as a saturated solution
- Sodium fluorosilicate is a salt added as an unsaturated solution
Fluorosilicic Acid (H$_2$SiF$_6$) FSA

- Transparent, ranging from water-white to colored
- FSA is in equilibrium with volatile HF and SiF$_4$ — HF boils just below room temperature
- Not actually a discrete compound: it is actually an aqueous solution of various polymers including SiF$_6^-$, SiF$_4^-$, Si(OH)$_2$F$_2$ anions and protonated water
Trends over time

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Percent of population</th>
<th>Systems</th>
<th>Percent of systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorosilicic acid</td>
<td>10,285,630</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium fluorosilicate</td>
<td>24,588,937</td>
<td>60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium fluoride</td>
<td>5,186,351</td>
<td>13%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonium silicate calcium fluoride</td>
<td>73,000</td>
<td>0.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorosilicic acid</td>
<td>80,019,175</td>
<td>63%</td>
<td>5,876</td>
<td>59%</td>
</tr>
<tr>
<td>Sodium fluorosilicate</td>
<td>36,084,896</td>
<td>28%</td>
<td>1,635</td>
<td>16%</td>
</tr>
<tr>
<td>Sodium fluoride</td>
<td>11,701,979</td>
<td>9%</td>
<td>2,491</td>
<td>25%</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorosilicic acid</td>
<td>152,501,133</td>
<td>81%</td>
<td>9,125</td>
<td>75%</td>
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<tr>
<td>Sodium fluorosilicate</td>
<td>24,224,615</td>
<td>13%</td>
<td>1,208</td>
<td>10%</td>
</tr>
<tr>
<td>Sodium fluoride</td>
<td>12,815,339</td>
<td>7%</td>
<td>1,825</td>
<td>15%</td>
</tr>
</tbody>
</table>
NSF Standard 60

Key concept is SPAC (Specific Product Allowable Content) not to exceed 10% of allowable MCL for substance

Fluoride products

Allowable product content
10% MCL

MCL
# NSF Certification Testing, 216 samples
## 2007-2011 testing

<table>
<thead>
<tr>
<th></th>
<th>Samples with measurable detectable levels Percentage</th>
<th>Mean concentration in all samples ppb</th>
<th>Maximum measured contaminant concentration ppb</th>
<th>NSF/ANSI Standard 60 Single Product Allowable concentration ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>50%</td>
<td>0.15</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Barium</td>
<td>2%</td>
<td>0.042</td>
<td>0.6</td>
<td>200</td>
</tr>
<tr>
<td>Chromium</td>
<td>&lt;1%</td>
<td>0.039</td>
<td>0.3</td>
<td>10</td>
</tr>
<tr>
<td>Copper</td>
<td>&lt;1%</td>
<td>0.039</td>
<td>0.091</td>
<td>130</td>
</tr>
<tr>
<td>Lead</td>
<td>&lt;1%</td>
<td>0.037</td>
<td>0.088</td>
<td>1.5</td>
</tr>
<tr>
<td>Thallium</td>
<td>&lt;1%</td>
<td>0.0079</td>
<td>0.01</td>
<td>0.2</td>
</tr>
</tbody>
</table>

All other metals, Antimony, Beryllium, Cadmium, Mercury, Selenium, not detected

**SOURCE:** NSF Fact Sheet on Fluoridation Products, February 15, 2013
Cost of additive discourages communities

• A historically declining market is stabilizing
  – 30 years ago, water fluoridation was about 25-30% of market, with aluminum and glass industries major uses
  – Today water fluoridation is 60% of market with 35% computer chip and solar panel production and 5% other uses

• March 2009 WERF study identified broader commodities market shortages and price increases

• Global trade of commodities is driving some production to lower cost locations and influencing costs
New Additive Delivery Vehicle

- Pelletized/tablet
- SBIR Program
- Erosion of calcium binder to release Sodium fluorosilicate
- Less personnel handling exposure
- Simpler operating strategy
SBIR moving to Phase II

- Phase I demonstrated feasibility of a tabletized sodium fluorosilicate

- Phase II includes
  - Tablet formulation refinement and full scale production
  - Prototype packaging to retain product integrity through handling and usage
  - Large scale testing in at least two PWS
  - Written protocols for directions and use
  - Plan for manufacturing and distribution
Percent US pop on PWS by water fluoride concentration

- 73.8% Recommended 0.7 mg/L
- 4% exceeds 2 mg/L
- 1.2% exceeds 4 mg/L
- 0.08% Fluoride exceeding MCL (16 states)
- 0.45% Fluoride exceeding SMCL (34 states)
- 26.2% Inadequate fluoride

USGS Estimate: private wells 14% of population
4% exceeds 2 mg/L ... 1.2% exceeds 4 mg/L
Important to know the level of fluoride in your drinking water

Thank you for your efforts in health promotion through water fluoridation

Questions?

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770-488-6076