Assessment of Taste and Odor Contributors from NSF Compliant Materials During Routine Main Replacement

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Background

- Routine water line replacement in Salem
- Replacing steel main with new 4”, 6”, and 8” DIP
- Steel line abandoned in place; new service lines to homes
- Residential area; no business or commercial activity. 37 homes affected by the new service
- Installation of the main lines were completed and disinfection and testing had occurred. No problems found

Background

- A few residents called complaining about a “petroleum” odor coming from their water
  - Turpentine
  - WD-40
  - Paint thinner
  - Gasoline
- Initial field investigation confirmed the odor; WQ parameters were normal
- Flushed from two locations
- Collected sample from two homes for further analysis
- 24 of the 37 homes had been switched over; door hangers were left advising residents to flush their lines

Background

- Samples were sent to Neilsen Analytical
  - VOCs by EPA 8260
- One sample collected from an outside spigot
- One sample from water collected the previous evening from a customer's kitchen sink
- Bottled water provided to affected residents as a precaution

Initial Results

Chemical Name	Detected level (ug/L)
Chloroform	48
Bromodichloromethane	1.9
Methyl Ethyl Ketone	66
1,2,4-Trimethylbenzene	6.9
1,3,5-Trimethylbenzene	2.5
4-Isopropyltolune	0.88
Napthalene	0.4
Toluene	0.3
Sec-Butylbenzene	1.9
n-Butylbenzene	0.3
n-Propylbenzene	0.2

Chemical Name	Description	Detected Level (parts per billion)	Risk-Based Limit (parts per billion)
Chloroform	A disinfection by-product, produced by the reaction of sodium hypochlorite (bleach) and naturally occurring organic matter in water. It is regulated under the Safe Drinking Water Act. Chloroform is found throughout the City's water distribution at levels ranging from 25 – 50 ppm	48	80
Bromodichloromethane	A disinfection by-product, produced by the reaction of sodium hypochlorite (bleach) and naturally occurring organic matter in water. It is regulated under the Safe Drinking Water Act. Chloroform is found throughout the City's water distribution at levels ranging from 0 – 5 ppm	1.9	80
Methyl Ethyl Ketone	Produced in large quantities and is used primarily in paints, solvents, and thinners. MEK is also used in plumbing installations to join plastic pipes. It is not considered a health threat at the concentrations detected.	66	7,100
1,2,4-Trimethylbenzene	A naturally occurring hydrocarbon found in coal tar and petroleum and is also produced industrially for use in solvents, thinners, and fuel additives.	6.9	15
1,3,5-Trimethylbenzene	Commonly used as a solvent in research and industry and as a component of building materials, furnishings, and chemical manufacturing.	2.5	12

Chemical Name	Description	Detected Level (parts per billion)	Risk-Based Limit (parts per billion)
4-Isopropyltoluene	A naturally occurring organic compound and is a constituent in the oils of cumin and thyme. It is often found in components of industrial solvents.	0.88	No Applicable Standard
Napthalene	Best known as the traditional, primary ingredient of mothballs. It is the single most abundant component of coal tar and is often found in petroleum based products.	0.4	6.2
Toluene	A common solvent, able to dissolve paints, paint thinners, lacquers, and rubber. It is used in many industrial and consumer products.	0.3	2,300
Sec-Butylbenzene	Slightly water soluble, a colorless liquid used as a solvent for coating compositions, organic synthesis, plasticizer, and surface active agents.	1.9	61
n-Butylbenzene	An intermediate for chemical manufacturing and a raw material for liquid crystals.	0.3	61
n-Propylbenzene	A solvent, used in textile dyeing and printing; a pollutant from asphalt and landfill leachate; and a constituent of petroleum and coal.	0.2	61

Follow-up

- Based on the results, all 24 homes previously connected to the new line were disconnected and placed back on the old steel main
- The new main was cut-away from the City's water system and turned over to the contractor
- The same chemicals were detected at another of the contractor's sites – no homes had been connected
- Samples were collected from all 24 homes for VOC analysis
- The contractor conducted testing on material used at the job site including cut-away pieces of pipe, new pipe, appurtenances, soil from the site, and pipe lube used in the installation

Contractor Investigation

- VOC testing by the contractor detected the same chemical signature on a piece of unused pipe and a sample of the pipe lube dissolved in water.
- Both products were NSF certified; based on concentrations detected, it seemed more likely that the source was the pipe lube
- Inquiries with the pipe lube manufacturer produced certified NSF compliance reports…however, it is all in the way you test it!

Further Testing

Pipe Lube A vs Pipe Lube B

Solids extraction (or what is really in this stuff)

Chemical	Pipe Lube A (mg/kg)	Pipe Lube B (mg/kg)
Acetone	5	22
Toluene	4.2	ND
1,2,4-Trimethylbenzene	4.1	ND
1,3,5-Trimethylbenzene	1.4	ND
n-Propylbenzene	0.6	0.1
4-Isopropyltoluene	0.6	0.4

Further Testing

Pipe Lube A vs Pipe Lube B

3-day exposure testing (1g/1L DI)

Chemical	Pipe Lube A (ug/L)	Pipe Lube B (ug/L)
Acetone	8	42
Toluene	1.1	ND
1,2,4-Trimethylbenzene	11	ND
1,3,5-Trimethylbenzene	4.0	ND
n-Propylbenzene	1.3	0.3
4-Isopropyltoluene	1.1	0.5

Also detected: sec-butylbenzene, n-butylbenzene, 2-Chlorotoluene, ethylbenzene

NSF International

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Standard 61: Drinking Water System Components – Heath Effects

- Establishes minimum health effects for chemical contaminants and impurities
  - Indirectly imparted from products, components, and materials used in drinking water systems
  - It DOES NOT establish performance, taste and odor, or microbial growth support requirements.
- Covers specific materials or products that come into contact with drinking water, drinking water chemicals, or both

Standard 61

- Materials covered:
  - Process media, protective materials, joining and sealing materials, pipes and related products, mechanical devices for treatment/transmission, and mechanical plumbing devices
- Not covered:
  - Point-of-use drinking water treatment devices
  - Fire hydrants

Key Terms in Std. 61

- Single product allowable concentration (SPAC)
  - The max concentration of a contaminant in drinking water that a single product is allowed to contribute
- Total allowable concentration (TAC)
  - The max concentration of a non-regulated contaminant allowed in a public drinking water supply
- Diluted surface area (DSA)
  - The surface area/volume ratio of a product calculated using its actual wetted surface area for the end use for which it is being evaluated

NSF Certification?

- Results provided to NSF were not “inconsistent” with results obtained by NSF for Std. 61 cert.
- Testing protocols were quite different, i.e. “apples to oranges”
- Some chemicals are grouped together in classes and not evaluated on an individual basis
  - 1,2,4- and 1,3,5-trimethylbenzene are in Naptha class and have a combined TAC/SPAC of 50 ppb
- SPAC are much higher than detected
  - Acetone – SPAC 600 ppb
  - Toluene – SPAC 1000 ppb

NSF Certification

- Generally, SPACs and TACs are more stringent than EPA MCLs
- NSF covers far more chemicals than SDWA regulations
  - Of all chemicals detected, only toluene is regulated under SDWA
- NSF uses risk based concentrations to set standards
- City used EPA Region 6 RCRA screening levels for human health effects levels

NSF Testing Procedures

- Substance is “exposed” to water – determining what chemicals will partition to the water
- Minimum surface-area-to-volume ratio of $15 cm^2/L$
  - Substance is applied to glass panel according to manufacturer’s instructions and completely exposed to extraction water
- Depending on application, could require cold or hot exposure or both
- Conditioned to simulate pre-use flushing and disinfection procedures

Exposure Sequence for Cold Applications

Exposure temp	Exposure time	Elapsed time	Comment
23 +/- 1 ^{o}C	24 +/- 1 h	1 d	Extraction water decanted and re-filled
23 +/- 1 ^{o}C	24 +/- 1 h	2 d	Extraction water decanted and re-filled
23 +/- 1 ^{o}C	24 +/- 1 h	3 d	Extraction water collected for analysis

Key Points from NSF Certification

- The standard is not concerned with acute contamination from materials
- The purpose is to protect health from exposure over the course of normal use
- If proper procedures are followed during construction/installation, NSF certification will protect public health
- NSF does not make any secret that they are not concerned with taste and odor issues

Future Work

- Conduct more extensive testing that more closely follows NSF procedures
- Expand the number/brands of lubricants
- Based on results, try to work some screening criteria into specs for new construction
- Standardize products used be City forces
  - Pipe lube “A” has been turned over to wastewater