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Companion Guide to ATSDR's Health Consultation on Sulfolane

Overview

The Alaska Department of Health and Social Services (DHSS), Division of Public Health, asked the Agency for Toxic Substances and Disease Registry (ATSDR), a federal public health agency, to provide a health consultation for the chemical sulfolane. Last fall, sulfolane was found in residential wells in North Pole. No state or federal screening guidelines exist for sulfolane in drinking water, so DHSS asked ATSDR to make recommendations to protect public health. Sulfolane is an industrial solvent most commonly used in refining oil to make gasoline.

Part I explains what ATSDR's recommendations mean for North Pole residents, and DHSS's next steps. Part II of this companion guide explains how ATSDR derived their "public health action levels" for sulfolane in drinking water, as described in their health consultation on sulfolane (see page 4 for how to get a copy).

Background

In October 2009, sulfolane was discovered in groundwater near residential homes in North Pole, and residents had been exposed through drinking water from wells in the area. The U.S. Environmental Protection Agency does not have a "maximum contaminant level", or MCL, for sulfolane in drinking water. As a result, DHSS specifically asked ATSDR to recommend an acceptable level for sulfolane in drinking water to protect public health, as well as to describe potential health effects of sulfolane exposure.

Part I. Q&A: What ATSDR's recommendations mean for North Pole residents

ASTDR has provided "public health action levels" for sulfolane in drinking water. A public health action level is a recommended, but not required, level above which a public health intervention might be needed. The action level can be used as a screening tool, because water concentrations of a chemical (contaminant) below that amount do not pose a public health concern. Public health interventions are actions taken to reduce further chemical exposure, such as switching to another drinking water source.

ATSDR's recommended action levels for sulfolane in drinking water

Population group	Sulfolane in drinking water ($\mu\text{g/l}$ or ppb)	Water intake per day	Body weight
Infants	25	1 liter	10 kg (22 lb)
Children	40	1 liter	16 kg (35 lb)
Adults	87.5	2 liters	70 kg (154 lb)

For adults, the acceptable level of sulfolane in drinking water is 87.5 micrograms of sulfolane per liter of water (87.5 $\mu\text{g/l}$), which is the same as 87.5 parts per billion (ppb). The level of 87.5 ppb assumes that the average adult consumes two liters (about two quarts) of water daily and weighs 70 kilograms (kg), or about 154 pounds. In the same way, the levels of 25 ppb for infants and 40 ppb for children reflect consumption of an average of one liter of water per day and bodyweights of 22 pounds and 35 pounds, respectively.

Q: My well water has sulfolane concentrations that are higher than ATSDR's recommended levels. Does this mean I'm going to get sick?

A: We don't think so. The doses of sulfolane that North Pole residents could have consumed are hundreds of times lower than the doses that have caused health effects in laboratory animals.

For example: The doses of sulfolane that caused serious health effects in guinea pigs in the short-term, including their ability to control body temperature, central nervous system toxicity or death, are **over 500 times higher** than the *lowest* dose that caused less serious sub-chronic health effects (2.5 mg/kg/d) in guinea pigs.

Similarly, the lowest sulfolane dose that caused sub-chronic health effects (2.5 mg/kg/d) in guinea pigs is **at least 100 times higher** than the dose a person would receive from drinking water containing 250 ppb sulfolane (**100, 156, or 357 times higher** than an infant, child or adult dose, respectively).

So, even though the sulfolane levels in some North Pole wells exceed ATSDR's action levels, we don't expect the sulfolane exposure to cause health effects in residents. But we can't be certain, given the lack of chronic toxicity information for sulfolane. In adopting ATSDR's levels, we recommend taking action to reduce sulfolane exposures. Fortunately, the Flint Hills refinery has been proactive in this regard by giving affected residents bottled water. Plans to hook up these residents to the city water supply will provide longer-term protection to North Pole residents.

Q: My well tested above the ATSDR levels, and I'm concerned about my kids. They drank this water when they were little. Are they going to have health problems in the future?

A: We can't answer this with 100% certainty because there isn't adequate scientific research, as is the case with many chemicals that are used today. This is very frustrating for all of us because we want to have a straight answer. We can say that there's no evidence suggesting that the levels of sulfolane in the North Pole wells are dangerous to people, but without long-term studies, we can't be certain of no health effects. So, we're recommending lower action levels and a permanent move to a sulfolane-free water source. That makes the most sense, in light of all the uncertainty and our desire to be cautious.

Q: Now that we have ATSDR's report, what is DHSS going to do?

A: We anticipate writing two health consultations for North Pole. The first one will address community concerns about how they have been using well water more recently, for example, gardening,

showering/bathing, and feeding pets. We hope to have this report done in the next few months. The second health consultation will evaluate past exposures to sulfolane in drinking water. We recognize that potential past exposure, possibly for many years, is one of the biggest concerns that North Pole residents may have right now. To address concerns related to past exposures, we need modeling projections of past levels of sulfolane in groundwater over time. We anticipate getting that information from Flint Hills and the Alaska Department of Environmental Conservation in the fall of 2010.

Part II. How ATSDR derived its public health action levels for sulfolane

ATSDR's Division of Toxicology and Environmental Medicine reviewed all the toxicity studies and reports on sulfolane that were available. Information on the health effects of sulfolane has been limited to animal studies. All of these studies looked at the health effects from either acute (one to 14 days) or sub-chronic (15 to 364 days) exposure to sulfolane at high doses (levels). Acute animal studies often include one-time exposure, often using a very high lethal dose. ATSDR did not find any chronic studies (exposure for one year or longer) for sulfolane.

The longest sub-chronic study was by Zhu et al. (1987). This study looked at guinea pigs after six months of daily oral exposure to sulfolane in food at four different doses: 0.25, 2.5, 25, or 250 milligrams of sulfolane per kilogram of bodyweight per day (mg/kg/d). This study found changes to the liver and spleen at all dose levels except the lowest dose. From this, the study's researchers identified a NOAEL, or No Observed Adverse Effect Level, of 0.25 mg/kg/d for guinea pigs orally exposed to sulfolane. A NOAEL is the *highest* dose of a chemical that has been found to have no harmful health effect in animal studies.

In addition to a review of published studies and reports on sulfolane, ATSDR used computer modeling to predict "how toxic" sulfolane might be based on its physical properties.

ATSDR made these observations from the literature review and computer modeling for sulfolane:

- Sulfolane is toxic (harmful) at high doses in test animals with acute and sub-chronic exposures.
- A six-month study (Zhu et al. 1987) showed effects on the liver and spleen of guinea pigs.
- An oral NOAEL for guinea pigs was identified at 0.25 mg/kg/d.
- Guinea pigs were more sensitive to the effects of sulfolane than rats.
- Computer modeling predicted that sulfolane is probably not carcinogenic (cancer-causing) in rats or mice, but could cause developmental problems in animals (two animal studies support this).
- No studies were available on the chronic health effects of sulfolane.
- Computer modeling predicted that sulfolane may be mutagenic (cause gene changes), but laboratory tests showed that sulfolane is not mutagenic.

As there are no studies that have looked for health effects in people who have been exposed to sulfolane, scientists and toxicology experts must rely on animal data and computer modeling to make recommendations on what is a "safe level" of exposure for people. When there is little scientific data about a chemical, scientists use a higher "uncertainty factor" or layer of protection to derive a "safe level" to protect human health.

Based on these observations, ATSDR applied two uncertainty factors of 10 to the NOAEL of 0.25 mg/kg/d from the Zhu guinea pig study to calculate action levels for three population groups (see table above). One uncertainty factor of 10 was used to account for potential differences in sensitivity between test animals and humans. Another uncertainty factor of 10 was used to account for population

differences in sulfolane sensitivity (meaning that some people are likely to be more sensitive to sulfolane than others).

Dividing the NOAEL by the uncertainty factors (0.25 mg/kg/d divided by 100) produces an acceptable level of exposure for sulfolane in drinking water of **0.0025 mg/kg/d, or 2.5 µg/kg/d** (micrograms/kg/d). This level is then multiplied by body weight in kilograms and divided by water intake in liters to come up with an action level for a given population.

ATSDR notes that the Canadian Council of Ministers of the Environment also derived a “screening level” for sulfolane in a 2006 report, using a different study, different uncertainty factors, and different exposure assumptions than ATSDR. The Canadian level (referred to as a “source guidance value for groundwater”) for sulfolane is 90 µg/l, or 90 ppb for adults, which is very close to ATSDR’s recommended level of 87.5 ppb for adults.

Please contact us with your questions and concerns at:

DHSS, Division of Public Health, Environmental Public Health Program: Nim Ha, health educator (907-269-8028) or Lori Verbrugge, toxicologist (907-269-8086).

You can access the ATSDR health consultation on sulfolane at:

<http://www.epi.alaska.gov/eh/sulfolane/ATSDRSulfolaneHC.pdf>

DHSS Sulfolane Health Fact Sheet is available at:

<http://www.epi.alaska.gov/eh/sulfolane/SulfolaneHealthFactSheet.pdf>