The ToxGuide™ is developed to be used as a pocket guide. Tear off at perforation and fold along lines.

## Sources of Exposure

### General Populations

- Human exposure to perchlorate is expected to occur through the ingestion of food and milk. The Food and Drug Administration (FDA) recently estimated that the US population ingests from 0.08 to 0.39 µg/kg/day perchlorate from food items.
- Human exposure to perchlorate also can occur through the ingestion of water, as it has been found in drinking water supplies, tap water samples, and groundwater at some locations.
- Efforts are being made to determine the relative contribution of perchlorate from food and water.
- Sources of perchlorates include rocket fuel, flares, gunpowder, temporary adhesives, electrolysis baths, batteries, drying agents, etching agents, oxygen generating systems, matches, chlorine and chlorine based cleaners, and pool chlorination chemicals.
- Chewing tobacco could be a source of exposure because perchlorate has been detected in several brands of chewing tobacco.
- Other chemicals, such as thiocyanate (in cigarette smoke and food) and nitrate (in food) are known to inhibit iodide uptake.

### Occupational Populations

- Occupational exposure to perchlorates may occur through the inhalation of dusts formed during their manufacture and use.
- Deposition of perchlorate dust into the mouth is also possible.

## Toxicokinetics and Normal Human Levels/Biomarkers

### Toxicokinetics

- Perchlorate appears to be readily absorbed by the digestive system after oral exposure and enters the bloodstream within a few hours of ingestion.
- Perchlorate is rapidly taken up into the thyroid gland by an active transport mechanism.
- Perchlorate does not appear to be modified in the body, either by degradation or covalent binding.
- Perchlorate is rapidly eliminated from the body in the urine with half-times of approximately 8-12 hours in humans. However, recent studies have shown widespread exposure to low levels of perchlorate by the general population, so exposure may be frequent.

### Normal Human Levels

*Urine*

- In 2,820 participants in a national survey (2001-2002), the geometric mean in urine was 3.54 µg/L.

### Biomarkers

- Urine is a convenient testing medium for perchlorate. It might be detectable for only a few days after exposure because it leaves the body so rapidly. Because it is found in food and may be present in drinking water, detection would be more likely.
- Levels of iodide in serum or urine, and levels of T3, T4, and TSH in serum, are not specific biomarkers of effect for perchlorate because other chemicals like thiocyanate or nitrate also inhibit iodide uptake.

## Environmental Levels

### Environmental Levels

*Food*

- Perchlorate has been found in a wide variety of foods consumed by the U.S. population. The FDA's Total Diet Study revealed that 74% of the foods analyzed had at least one sample of detected perchlorate. Estimation of dietary intake showed the lowest intake to be 0.08–0.11 µg/kg/day for males aged 25–30 years and the highest intake to be 0.35–0.39 µg/kg/day for children 2 years old. The majority of the perchlorate estimated intake by infants 6-11 months comes from baby foods, such as infant formula and dairy foods. Dairy foods contribute about half of the total estimated daily intake of perchlorate by children 2, 6, and 10 years old. Vegetables and dairy foods combined account for between 46% and 59% of the total estimated intake of perchlorate by teenagers and adults.

*Water*

- EPA collected drinking water occurrence data for perchlorate from 3,865 Public Water Systems (PWS) between 2001 and 2005. EPA found that approximately 160 (4.1%) of the PWSs that sampled and reported had at least 1 analytical detection of perchlorate (in at least 1 entry/sampling point) greater than or equal to the reporting limit of 4 µg/L. These 160 are located in 26 States and 2 territories. Approximately 1.9% (or 637) of the 34,331 samples collected (by these 3,865 PWSs) had positive detections of perchlorate at levels ≥4 µg/L. The average concentration of perchlorate in those samples in which perchlorate was detected was 9.85 µg/L and the median concentration was 6.40 µg/L (the average and median concentrations of perchlorate in all samples was <4 µg/L).

# ToxGuide™ for Perchlorate and Perchlorate Salts

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**U.S. Department of Health and Human Services**
**Public Health Service**
**Agency for Toxic Substances and Disease Registry**
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ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

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## Chemical and Physical Information

### Perchlorates are colorless salts

- Five perchlorates are manufactured in large amounts: magnesium perchlorate, potassium perchlorate, ammonium perchlorate, sodium perchlorate, and lithium perchlorate.
- In water, perchlorate salts dissociate into a positively-charged cation and the negatively-charged perchlorate anion.
- Perchlorates can be very reactive chemicals, producing large amounts of heat capable of exploding.
- Perchlorates are used in rocket motors, fireworks, road flares and explosives and are produced in the U.S., as well as imported from other countries.
- Ammonium perchlorate is produced in large amounts in the United States because it is used in solid rocket propellants.
- Perchlorate is used to prevent technetium uptake during medical imaging; it has also been used to counter the thyroid effects of the drug amiodarone.
- Perchlorates can also form naturally in the atmosphere, leading to trace levels of perchlorate in precipitation. High levels of perchlorates occur naturally in some locations such as regions of west Texas and northern Chile.
- Perchlorate has been detected as an impurity in certain consumer products such as bleach.

## Routes of Exposure

- Ingestion (drinking contaminated water, eating contaminated food including milk).
- Inhalation (breathing dusts or suspended particles).
- Dermal (contact with contaminated soil).

### Perchlorate in the Environment

- Perchlorate has been found in food, including cow's milk, and in water.
- Factories that make or use perchlorates may release them.
- Perchlorate entered the environment where rockets were made, tested, and disassembled and from fireworks, explosives, flares, and similar products. Also, perchlorate is an impurity in certain industrial and consumer products, such a cleansers and bleaches, which also may result in its discharge to the environment.
- Perchlorate also occurs naturally in the environment.
- Perchlorate released to the environment is deposited in soil or water (rivers, streams, lakes, and ponds) and can leach into groundwater from soil.
- Perchlorate has been found in a wide variety of foods including eggs, milk, vegetables, and fruits.
- Perchlorate will persist in water and soil for several years, but may eventually be degraded by microorganisms.

## Relevance to Public Health (Health Effects)

**Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.**

### Minimal Risk Levels (MRLs)

*Inhalation*

- No MRLs for inhalation exposure have been derived for perchlorate since adequate data were not available by this route of exposure.

*Oral*

- ATSDR adopted the National Academy of Sciences chronic reference dose (RfD) of 0.0007 mg/kg/day for the chronic oral MRL. The MRL protects the most sensitive population, the fetuses of pregnant women who might have hypothyroidism or iodide deficiency, and also provides protection for infants and developing children.

### Health Effects

- The main target organ for perchlorate toxicity in humans is the thyroid gland.
- Perchlorate inhibits the thyroid's uptake of iodine. Iodine is required as a building block for the synthesis of thyroid hormone.
- Thyroid hormones regulate certain body functions after they are released into the blood. These include metabolism, growth and neurological development in children. Exposure of people to excessive amounts of perchlorate for a long time may lower the thyroid activity, leading to a condition called hypothyroidism.
- Perchlorate's inhibition of iodide uptake by the thyroid must be great enough to cause hypothyroidism. The prevalence of hypothyroidism is about 5% in the general population of the United States, but there is no evidence that any of this percentage is due to perchlorate exposure.
- Because thyroid hormones play a critical role in the neurological development of the fetus, there is concern that hypothyroidism (maternal and fetal) during pregnancy could result in neurodevelopmental effects.
- It is relevant to point out that other chemicals in the diet and in tobacco smoke also can affect the thyroid gland in ways similar to perchlorate.

### Children's Health

- The most sensitive population is fetuses of pregnant women who might have hypothyroidism or iodide deficiency.
- Infants and developing children may be more likely to be affected by perchlorate than adults because thyroid hormones are essential for normal growth and development.

### Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Toxicological Profile for Perchlorates. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.