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Testimony of Representative Genevieve McDonald

To the Joint Standing Committee on Criminal Justice and Public Safety

In FAVOR of L.D. 514

An Act To Establish and Promote a System of Safe Disposal of Expired Marine Flares

Senator Deschambault, Representative Warren, and Distinguished Members of the Joint Standing Committee on Criminal Justice and Public Safety, please accept my testimony in favor of L.D. 514, An Act To Establish and Promote a System of Safe Disposal of Expired Marine Flares.

In addition to serving in the legislature, I am a commercial fisherman. There are thousands of commercial vessels in the state of Maine required to have flares onboard, and no reliable, established system for their safe disposal. In accordance with United States Coast Guard requirements, marine flares expire 42 months after the date of manufacture and commercial vessels must replace them. The U.S.C.G. does not accept expired marine flares for disposal. There are organizations and agencies that will accept expired flares for safety training, but this option is not consistent. Expired marine flares become less stable and less reliable over time. With no established disposal system, flares are fired off in non-emergency situations simply to get rid of them. 4th of July is often extra spectacular.

Marine flares contain perchlorate, an industrial chemical used as an oxidizer in rocket fuel and explosives. It is toxic, and highly water soluble. Please find the attached EPA Technical Fact Sheet. An established disposal system for expired marine flares would reduce the risks associated with the storage of hazardous materials, and reduce the introduction of perchlorate to the marine ecosystem. Thank you for your consideration.

United States
Environmental Protection
Agency

Technical Fact Sheet – Perchlorate

January 2014

TECHNICAL FACT SHEET – PERCHLORATE

At a Glance

- White crystalline solid or colorless liquid.
- Both naturally occurring and man-made anion.
- Sampling at current federal sites as well as at Formerly Used Defense Sites detected perchlorate primarily in association with sites historically involved in the manufacture, maintenance, use and disposal of ammunition and rocket fuel.
- Highly soluble in water; migrates quickly from soil to groundwater.
- Primary pathways for human exposure include ingestion of contaminated food and drinking water.
- Short-term exposure to high doses may cause eye and skin irritation, coughing, nausea, vomiting and diarrhea.
- Health-based goals or drinking water standards developed by various states.
- Various detection methods available include ion chromatography, liquid chromatography, mass spectroscopy and electrospray ionization.
- Common treatment technologies include ion exchange, bioreactors and in situ bioremediation.

Introduction

This fact sheet, developed by the U.S. Environmental Protection Agency (EPA) Federal Facilities Restoration and Reuse Office (FFRRO), provides a summary of the contaminant perchlorate, including physical and chemical properties; environmental and health impacts; existing federal and state guidelines; detection and treatment methods; and additional sources of information. This fact sheet provides basic information on perchlorate to site managers and other field personnel who are addressing perchlorate contamination at cleanup sites or in drinking water supplies.

Perchlorate is a persistent contaminant of concern that has presented a number of issues to the government, the private sector and other organizations and interested parties. These issues include health effects and risks, regulatory standards and cleanup levels, degradation processes and treatment technologies (EPA FFRRO 2005).

What is perchlorate?

- Perchlorate is a naturally occurring and man-made anion that consists of one chlorine atom bonded to four oxygen atoms (ClO_4^-) (EPA FFRRO 2005; ITRC 2005).
- Perchlorate may occur naturally, particularly in arid regions such as the southwestern United States (Rao and others 2007).
- Manufactured forms of perchlorate include perchloric acid and salts such as ammonium perchlorate, sodium perchlorate and potassium perchlorate (EPA FFRRO 2005; ITRC 2005).
- Perchlorate is found as a natural impurity in nitrate salts from Chile, which are imported and used to produce nitrate fertilizers and other products (EPA FFRRO 2005; ITRC 2005).
- Perchlorate is commonly used as an oxidizer in solid propellants, munitions, fireworks, airbag initiators for vehicles, matches and signal flares (EPA FFRRO 2005; ITRC 2005). It is also used in some electroplating operations and found in some disinfectants and herbicides (ATSDR 2008; ITRC 2005).

What is perchlorate? (continued)

- Of the domestically produced (high grade) perchlorate, 90 percent is manufactured for use in the defense and aerospace industries, primarily in the form of ammonium perchlorate (GAO 2005; ITRC 2005).
- Perchlorate has been used by the U.S. Department of Defense (DoD) as an oxidizer in munitions and missiles since the 1940s (EPA FFRRO 2005; ITRC 2005).

Exhibit 1: Physical and Chemical Properties of Perchlorate Compounds
(ATSDR 2008; EPA FFRRO 2005; ITRC 2005; NIH 2013; NIOSH 2013)

Property	Ammonium Perchlorate	Sodium Perchlorate	Potassium Perchlorate	Perchloric Acid
Chemical Abstracts Service (CAS) Numbers	7790-98-9	7601-89-0	7778-74-7	7601-90-3
Physical Description (physical state at room temperature)	White orthorhombic crystal	White orthorhombic deliquescent crystal	Colorless orthorhombic crystal or white crystalline powder	Colorless, oily liquid
Molecular weight (g/mol)	117.49	122.44	138.55	100.47
Water solubility (g/L at 25°C)	200	2,096	15	Miscible in cold water
Melting / Boiling point* (°C)	Melting Point: > 200 (Decomposes)	Melting Point: 471 to 482	Melting Point: 400 to 525	Melting Point: -112 Boiling Point: 19
Vapor pressure at 25°C (mm Hg)	Very low	Very low	Very low	6.8
Specific gravity (g/cm³)	1.95	2.52	2.53	1.77
Octanol-water partition coefficient (log K_{ow})	-5.84	-7.18	-7.18	-4.63

*Different melting point temperatures are identified in literature.
Abbreviations: g/mol – grams per mole; g/L – grams per liter; °C – degrees Celsius; mm Hg – millimeters of mercury; g/cm³ – grams per cubic centimeter.

What are the environmental impacts of perchlorate?

- Perchlorate is highly soluble in water, and relatively stable and mobile in surface and subsurface aqueous systems. As a result, perchlorate plumes in groundwater can be extensive. For example, the perchlorate plume at a former safety flare site (the Olin Flare Facility) in Morgan Hill, California, extends more than 9 miles (EPA 2011; ITRC 2005).
- Because of their low vapor pressure, perchlorate compounds and the perchlorate anion do not volatilize from water or soil surfaces to air (ATSDR 2008; ITRC 2005).
- Perchlorate released directly to the atmosphere is expected to readily settle through wet or dry deposition (ATSDR 2008).
- High concentrations of perchlorate have been detected primarily at current and Formerly Used Defense Sites historically involved in the manufacture, testing and disposal of ammunition and rocket fuel or at industrial sites where perchlorate is manufactured or used as a reagent during operations (ATSDR 2008; ITRC 2005).
- Types of military and defense-related facilities with known releases include missile ranges and missile and rocket manufacturing facilities. However, since site-specific documentation may not be available and based on historical uncertainties, it is generally difficult to identify specific military sites with known perchlorate releases. From 1997 to 2009, the Department of Defense reported perchlorate detections at 284 (almost 70 percent) of its installations sampled (GAO 2010; ITRC 2005).
- In addition, the past disposal of munitions in either burial pits or by open burning and open detonation may have resulted in releases to the environment. The amount of perchlorate released can vary depending on the length of time the disposal area was used and the types of munitions disposed of in the area (ITRC 2005).

What are the environmental impacts of perchlorate? (continued)

- Studies have shown perchlorate accumulates in some food crop leaves, tobacco plants and in broad-leaf plants (ATSDR 2008).
- Surveys conducted by the U.S. Food and Drug Administration have detected perchlorate in food crops and milk (FDA 2008).
- As of October 2009, perchlorate had been detected at varying levels in drinking water, groundwater, surface water, soil or sediment at private and federal facilities in 45 states, three U.S. territories and Washington D.C. The maximum concentrations reported in any media ranged from less than 4 parts per billion (ppb) to more than 500,000 ppb (ASTSWMO 2011; GAO 2010).
- EPA reported perchlorate detections at more than 40 hazardous waste sites on the EPA National Priorities List as of June 2010 (GAO 2010).

What are the routes of exposure and the health effects of perchlorate?

- Primary pathways for human exposure to perchlorate are ingestion of contaminated food and drinking water (ATSDR 2008; EPA FFRRO 2005).
- Perchlorate is readily adsorbed after oral exposure and can migrate from the stomach and intestines to the bloodstream (ATSDR 2008).
- The thyroid gland is the primary target of perchlorate toxicity in humans. Thyroid hormones play an important role in regulating metabolism and are critical for normal growth and development in fetuses, infants and young children. Perchlorate can interfere with iodide uptake into the thyroid gland at high enough exposures, disrupting the functions of the thyroid and potentially leading to a reduction in the production of thyroid hormones (ATSDR 2008; Cal/EPA 2012; NAS 2005).
- Study results indicate that exposure to high doses of perchlorate can result in the decrease of body weight, cause hypertrophy of the thyroid gland and decrease gene expression of thyroglobulin (Tg) and thyroperoxidase (TPO), which are involved in the biosynthesis of thyroid hormones (Wu and others 2012).
- Potassium perchlorate was historically used to treat hyperthyroidism and Graves' Disease (an autoimmune disorder) because of its ability to inhibit thyroid iodide uptake (ATSDR 2008; NAS 2005).
- Studies conducted on rodents showed that perchlorate concentrations below that required to alter thyroid hormone equilibrium are unlikely to cause thyroid cancer in human beings (ATSDR 2008; EPA IRIS 2005).
- Short-term exposure to high doses of ammonium, sodium or potassium perchlorate may cause eye, skin and respiratory tract irritation, coughing, nausea, vomiting and diarrhea. Perchloric acid is corrosive to the eyes, skin and respiratory tract, and short-term exposure to high doses may cause sore throat, coughing, labored breathing, deep burns, loss of vision, abdominal pain, vomiting or diarrhea (NIOSH 2013).

Are there any federal and state guidelines and health standards for perchlorate?

- The EPA assigned perchlorate a chronic oral reference dose (RfD) of 0.0007 milligrams per kilogram per day (mg/kg/day) (EPA IRIS 2005).
- The Agency for Toxic Substances and Disease Registry (ATSDR) has established a minimal risk level (MRL) of 0.0007 mg/kg/day for chronic-duration oral exposure (365 days or more) to perchlorate (ATSDR 2008, 2013).
- EPA has decided to regulate perchlorate under the Safe Drinking Water Act. EPA has initiated the process of proposing a national primary drinking water regulation (EPA 2012b).
- The EPA established an Interim Lifetime Drinking Water Health Advisory of 15 micrograms per liter (µg/L), which is a concentration of a perchlorate in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure (EPA 2009, 2012a).
- EPA has calculated a residential soil screening level (SSL) of 55 milligrams per kilogram (mg/kg) and an industrial SSL of 720 mg/kg for perchlorate and perchlorate salts (ammonium, potassium, sodium and lithium) (EPA 2013). [1]

[1] Screening Levels are developed using risk assessment guidance from the EPA Superfund program. These risk-based concentrations are derived from standardized equations combining exposure information assumptions with EPA toxicity data. These calculated screening levels are generic and not enforceable cleanup standards but provide a useful gauge of relative toxicity.

Are there any federal and state guidelines and health standards for perchlorate? (continued)

- EPA calculated a tap water screening level of 11 µg/L for perchlorate and perchlorate salts (EPA 2013).
- The EPA Office of Solid Waste and Emergency Response (OSWER) recommended a preliminary remediation goal (PRG) of 15 µg/L at Superfund sites (where there is an actual or potential drinking water exposure pathway), where no federal or state applicable or relevant and appropriate requirements exist under federal or state laws. PRGs are developed based on readily available information and are modified, as necessary, before final cleanup goals are established, based on information that becomes available during the remedial investigation/feasibility study (EPA 2009).
- Numerous states have promulgated enforceable standards for perchlorate in drinking water. For example, Massachusetts (2 µg/L) and California (6 µg/L) have established enforceable standards for perchlorate in drinking water (CDPH 2012; Massachusetts DEP 2006).
- California EPA released Draft California Human Health Screening Levels (CHHSLs) for perchlorate. The draft CHHSLs for perchlorate in soil are 28 mg/kg for residential property and 350 mg/kg for commercial/industrial property (Cal/EPA 2010).
- In 2012, California EPA's Office of Environmental Health Hazard Assessment (OEHHA) proposed to revise the existing Public Health Goal for perchlorate in drinking water from 6 µg/L to 1 µg/L (Cal/EPA 2012).
- At least 10 other states have also developed advisory levels or health-based goals for perchlorate, ranging from 1 to 18 µg/L for drinking water and 1 to 72 µg/L for groundwater (GAO 2010).

What detection and site characterization methods are available for perchlorate?

- The following methods can be used to analyze perchlorate in drinking water, groundwater, surface water and irrigation water:
  - EPA Method 314.0 - Ion Chromatography (EPA OGWDW 2012).
  - EPA Method 314.1 Rev 1.0 - Inline Column Concentration/Matrix Elimination Ion Chromatography with Suppressed Conductivity Detection (EPA OGWDW 2012).
  - EPA Method 314.2 - Two-Dimensional Ion Chromatography with Suppressed Conductivity Detection (EPA OGWDW 2012).
  - EPA Method 331.0 Rev. 1.0 - Liquid Chromatography/Electrospray Ionization/ Mass Spectrometry (EPA OGWDW 2012).
  - EPA Method 332.0 - Ion Chromatography with Suppressed Conductivity and Electrospray Ionization/Mass Spectrometry (EPA FFRRO 2005).
- The following methods can be used to analyze perchlorate in surface water, groundwater, wastewater, salt water and soil:
  - EPA SW-846 Method 6850 - High Performance Liquid Chromatography/Electrospray Ionization/Mass Spectrometry (EPA 2007a).
  - EPA SW-846 Method 6860 - Ion Chromatography/Electrospray Ionization/Mass Spectrometry (EPA 2007b).
- The presence of high amounts of other anions, such as chloride, sulfate or carbonate, may interfere with the analysis of perchlorate (EPA 1999).
- Researchers have demonstrated the ability to distinguish man-made and natural sources of perchlorate in water samples using chlorine and oxygen stable isotope ratio analysis (Bŏhlke and others 2005; ITRC 2005).

What technologies are being used to treat perchlorate?

- **Ex Situ Treatment**
  - Ion exchange using perchlorate-selective or nitrite-specific resins is a proven method for removal of perchlorate from drinking water, groundwater, surface water and other media. Laboratory-study results indicate that an electrically switched ion exchange system using a conductive carbon nanotube nanocomposite material could be used for the large-scale treatment of wastewater (ITRC 2008; DoD SERDP 2011).

What technologies are being used to treat perchlorate? (continued)

- A recent field study demonstrated the effective reduction of perchlorate to below detection limits in groundwater using a large-scale weak base anion resin ion exchange system (DoD ESTCP 2012b).
- A fluidized bed biological reactor (FBR) treatment train successfully treated low and high concentration levels of perchlorate in groundwater to meet the California drinking water standards (6 µg/L) in a field study (DoD ESTCP 2009b).
- Membrane technologies including electrodialysis, reverse osmosis and nanofiltration/ultrafiltration have been used to remove perchlorate from groundwater, surface water and wastewater; however, these all require subsequent disposal of the perchlorate removed (EPA FFRRO 2005; ITRC 2008).
- Liquid phase carbon adsorption using granular activated carbon (GAC) is used to remove low levels of perchlorate from groundwater and surface water. The adsorptive capacity of GAC may be increased through the addition of a surface-active coating to produce a modified or tailored GAC (Hou and others 2013; ITRC 2008).
- Laboratory study results indicate that ultraviolet laser reduction can be used to decompose low levels of perchlorate (below 100 µg/L) dissolved in water. This technology is currently undergoing laboratory testing and has not yet been commercialized or used in full-scale systems (ITRC 2008; Vellanki and others 2013).

❖ **In Situ Treatment**

- Enhanced in situ bioremediation using perchlorate-selective microbes can be an effective method for degrading perchlorate in groundwater and soil. Study results indicate that acetate and hydrogen addition as electron donor can increase perchlorate removal efficiency (ITRC 2008; Wang and others 2013).
- Recent field studies have evaluated in situ bioremediation of perchlorate in groundwater and soil using gaseous electron donors. Field study demonstration results indicate that a horizontal flow treatment well system can effectively deliver electron donor and promote the in situ biological reduction of perchlorate in groundwater (DoD ESTCP 2009c).
- A field study evaluated the use of gaseous electron donor injection technology for the anaerobic biodegradation of perchlorate in vadose zone soil. Results showed an average perchlorate destruction of more than 90 percent within the targeted 10-foot radius of influence within five months (DoD ESTCP 2009d).
- A field study evaluated the use of an emulsified oil biobarrier to enhance the in situ anaerobic biodegradation of perchlorate in groundwater. Within 5 days of injection, perchlorate was degraded from an initial concentration range of 3,100 to 20,000 µg/L to below detection limits (less than 4 µg/L) in the injection and nearby monitoring wells (DoD SERDP 2008).
- A field study demonstrated the effective use of an active biobarrier approach involving on-going groundwater recirculation and delivery of an electron donor and a semi-passive approach involving the periodic delivery of electron donor to create a biobarrier and promote perchlorate biodegradation in groundwater (DoD ESTCP 2009a, 2012a).
- Laboratory and field studies have demonstrated the potential for using monitored natural attenuation to treat perchlorate in groundwater (DoD ESTCP 2010).
- Several bench-scale tests have demonstrated the potential effectiveness of phytoremediation and constructed wetlands to treat perchlorate-contaminated media; limited field study demonstrations have been implemented. Recent laboratory study results indicate that the wetland plant, *Eichhornia crassipes*, may be an effective plant for constructing a wetland to remediate high levels of perchlorate in water based on its high tolerance and accumulation ability (He and others 2013; ITRC 2008).

Where can I find more information about perchlorate?

❖ Agency for Toxic Substances and Disease Registry (ATSDR). 2008. "Toxicological Profile for Perchlorates." www.atsdr.cdc.gov/toxprofiles/tp162.pdf

❖ ATSDR. 2013. "Minimal Risk Levels (MRL)" List. www.atsdr.cdc.gov/mrls/index.asp

❖ Association of State and Territorial Solid Waste Management Officials (ASTSWMO). 2011. "Perchlorate Policy Update." www.astswmo.org/Files/Policies_and_Publications/Federal_Facilities/2011.04_FINAL_Perchlorate_Policy_Update.pdf

Where can I find more information about perchlorate? (continued)

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Where can I find more information about perchlorate? (continued)

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Additional information on perchlorate can be found at EPA's www.cluin.org/perchlorate.

Contact Information

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