



# R.E.D. FACTS

## Chlorine gas

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### Pesticide Reregistration

All pesticides sold or distributed in the United States must be registered by EPA, based on scientific studies showing that they can be used without posing unreasonable risks to people or the environment. Because of advances in scientific knowledge, the law requires that pesticides which were first registered years ago be reregistered to ensure that they meet today's more stringent standards.

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. The Agency imposes any regulatory controls that are needed to effectively manage each pesticide's risks. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment.

When a pesticide is eligible for reregistration, EPA announces this and explains why in a Reregistration Eligibility Decision (RED) document. This fact sheet summarizes the information in the RED document for reregistration Case 4022, chlorine gas.

### Use Profile

Chlorine gas is used in water treatment to disinfect drinking water, swimming pools, ornamental ponds and aquaria, sewage and wastewater, and other types of water reservoirs. Chlorine gas also is used as a disinfectant, microbistat/microbicide and algicide in food processing systems, pulp and paper mill systems, and commercial and industrial water cooling systems. It is used in washing meat, fresh produce and seeds to control decay-causing microorganisms.

Chlorine is formulated as a pressurized gas and distributed in large stationary containers such as tank cars or trucks and 150-pound to 1-ton cylinders. It is intended for use only by trained, experienced personnel, under the supervision of the registrant and in accordance with state and municipal regulatory requirements.

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## **Regulatory History**

Chlorine gas was first registered in the U.S. in 1948, as a disinfectant for use in swimming pools, drinking water, cooling towers and sewage systems. In 1976, chlorine gas was classified for general use based on the premise that industrial users already were adequately trained in its use. Chlorine gas was declared exempt from the requirement of a tolerance when used in solution on raw agricultural commodities in 1991 because measurable residues are not expected. EPA required additional generic data in a Data Call-In notice issued in November 1993. Currently, 97 pesticide products containing the active ingredient chlorine gas are registered.

The Food and Drug Administration (FDA) regulates the use of chlorine gas in solution as a food contact surface sanitizer. EPA's Office of Water regulates its use in potable water systems.

## **Human Health Assessment**

### **Toxicity**

In human poisoning incidents involving accidental ingestion of household bleach, chlorine has caused a burning sensation in the mouth and throat, irritation to the digestive tract and stomach, and vomiting. Exposure to chlorine gas causes effects ranging from bronchitis, asthma and swelling of the lungs, to headaches, heart disease and meningitis. Acute exposure causes more severe respiratory and lung effects, and can result in fatalities. More often, however, the effects are not permanent; complete and rapid recovery generally occurs with treatment.

Chlorine disinfectants have been shown to cause occupational dermatitis or irritation of the skin. People who are asthmatic or allergic to chlorine may be at high risk for adverse reactions after inhaling or ingesting chlorine, for example, after drinking treated water.

Technical grade chlorine (gas and liquid) and its byproducts, hypochlorous acid and hypochlorite ions, are highly toxic and corrosive, and have been placed in Toxicity Category I (indicating the highest degree of acute toxicity) for oral, dermal, eye and inhalation effects. EPA waived several acute toxicity studies and all subchronic toxicity studies for chlorine due to its known acute toxicity and corrosiveness.

Review of a 2-year chronic inhalation study showed effects consistent with previous findings. Even the lowest exposures resulted in measurable cell destruction, primarily as pulmonary lesions. Additional long-term testing is not necessary since the likelihood of additional effects being identified for chlorine *per se* is remote.

Diverse results have been reported for chronic exposure to chlorine in drinking water. EPA has classified chlorine as a Group D carcinogen (not classifiable as to human carcinogenicity), based on a 1990 National Toxicology Program (NTP) study. That study showed equivocal evidence of cancer in female rats (increased leukemia) and no evidence in male rats or in male and

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female mice. The International Agency for Research on Cancer (IARC) also determined in 1991 that chlorinated drinking water is not classifiable as to human carcinogenicity. Chlorine has not been shown to cause reproductive, developmental or mutagenic effects.

### **Dietary Exposure**

Pursuant to 40 CFR 180.1095, Chlorine gas is exempt from the requirement of a tolerance when used pre- or postharvest on all raw agricultural commodities. Use of chlorine in food processing water systems to prevent decay of raw agricultural commodities may result in residues on treated produce; however, finite residues or residues above naturally occurring background levels are not expected. Similarly, if livestock ingest chlorine-treated water, finite residues or residues above background levels are not expected to occur in meat, milk or eggs.

Chlorine gas used as a food contact surface sanitizer on food, meat or poultry processing premises and equipment is under FDA's regulatory purview. EPA regulates contaminants in drinking water under the Safe Drinking Water Act (SDWA). The Office of Drinking Water has recently established a Maximum Residual Disinfectant Level (MRDL) of 4 mg/L for chlorine. An MRDL is an enforceable Federal Standard.

### **Occupational and Residential Exposure**

Chlorine gas is metered into water through closed systems in manufacturing processes or from large stationary containers such as tank cars, tank trucks and cylinders. Given current use patterns of chlorine gas, there is potential for dermal and inhalation exposure to applicators and other people exposed to chlorinated water including swimmers, bystanders and workers in food processing plants and water/sewage treatment plants.

Occupational exposure guidelines have been established by OSHA and other domestic and foreign sources. Post-application exposure to chlorine while swimming in treated pools is not believed to be significant, if label requirements are followed.

A significant number of accidents and injuries resulting from the use of chlorine gas as a pesticide have been reported by the American Association of Poison Control Centers, the Chlorine Institute, the California Pesticide Illness Surveillance Program and others. In California, most accidents involved maintenance or equipment failure of chlorinator systems. The most common FIFRA use-related exposures occurred at food processing plants. A significant number of the incidents reported were attributed to application error. While there were some residential pool incidents, most occurred in connection with public/commercial pool chlorinator systems. In Florida, four applicators have died as a result of incorrectly applying chlorine gas.

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## Human Risk Assessment

Risk to the public is not anticipated from consuming food or water treated with chlorine. Although residues may remain on fruits and vegetables as a result of their treatment with chlorine solution, these residues are exempt from tolerance requirements and are not believed to pose risks. Residues above background levels are not expected in meat, milk or eggs as a result of chlorine use in drinking water. Use of chlorine to sanitize food contact surfaces and food processing equipment presumably does not result in residues of concern in foods (this use is under FDA's jurisdiction). EPA's Office of Drinking Water regulates chlorine in drinking water supplies under the SDWA.

The Agency has concluded that there is a need to better characterize the reproductive and developmental risks associated with drinking water in order to assure that children, infants and fetuses not face unreasonable risk from chronic exposure to drinking water byproducts. Because of the high levels of exposure, both in terms of population (greater than 200,000,000) and individual consumption of chlorinated drinking water, it is necessary to assess the associated risks with greater certainty.

Three water treatment byproducts in particular have been identified for which the health effects need to be better characterized.

Bromodichloromethane, dichloroacetic acid, and dibromoacetic acid have been identified as having health effects in laboratory studies. Because these compounds are the most common toxicologically significant halogenated hydrocarbons that have not been completely characterized, additional testing on these compounds will improve the Agency's ability to assess chronic risks from drinking water exposure.

EPA has significant concerns about applicator and post-application exposure to chlorine gas because it is highly toxic for all routes of exposure. The greatest risk of poisoning accidents from chlorine is to applicators and bystanders from accidental exposures resulting from use of chlorine gas in public/commercial swimming pools, and to applicators and workers in industrial food settings. Two other uses, pulp/paper mills and cooling towers, also pose a significant risk because of chlorinator system failure and maintenance operations. The reported poisoning incidents strongly suggest that the use of chlorine gas in these situations presents a significant risk of acute toxicity to applicators, other workers and bystanders. To mitigate this risk, EPA is requiring Restricted Use Pesticide classification for the use of chlorine gas in food processing plants, public/commercial swimming pools, pulp/paper mills and cooling towers so that in the future these uses will be limited to trained, certified applicators. In addition, EPA is requiring significant revisions to product labeling through the RED, so labels will contain sufficient specific use information. The labeling improvements are expected to

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adequately address the risks associated with water/sewage treatment and residential pool use, which will still be classified as general use.

## **Environmental Assessment**

### **Environmental Fate**

Chlorine hydrolyses in water to form hypochlorite and hypochlorous acid. Hypochlorous acid is an oxidizing agent--it has a sanitizing effect on organic and inorganic contaminants. Disinfection by chlorination is achieved by maintaining a "free residual chlorine" concentration in solution.

When treated effluent is released into receiving waters, free residual chlorine dissipates rapidly (it has a half-life of 1.3 to 5 hours). The ultimate fate of chlorine-containing effluent is site specific, and depends on factors such as the chemical constituents of the receiving waters, their temperature, the dilution ratio and the intensity of sunlight.

### **Ecological Effects**

Studies on lithium hypochlorite were used to satisfy the data requirements for chlorine used as an industrial biocide, since both form hypochlorous acid when dissolved in water.

Lithium hypochlorite is practically non-toxic to birds on a subacute dietary basis. However, chlorine is very highly toxic to fish and freshwater invertebrates.

### **Ecological Effects Risk Assessment**

In receiving waters from facilities using chlorine, if acute levels of concern are exceeded, a significant risk to aquatic organisms and endangered aquatic organisms can be expected. Levels of concern (equaling one-half of the  $EC_{50}$ ) are 0.009 ppm for aquatic invertebrates, 0.023 ppm for freshwater fish, and 0.013 ppm for estuarine organisms. Levels of concern for endangered species (equaling one twentieth of the  $EC_{50}$ ) are 0.85 ppb for aquatic invertebrates, 2.3 ppb for freshwater fish, and 1.3 ppb for estuarine invertebrates.

Uses of chlorine that are **not** regulated under the NPDES permit program, including swimming pool, aquaria and indoor use patterns (fruit and vegetable rinsing and food processing), should produce only intermittent discharges of minimal concentration into lakes or streams, resulting in minimal environmental exposure.

Other chlorine uses, including water cooling tower, sewage treatment plant, and pulp and paper mill uses, are included in the NPDES permit programs administered by EPA's Office of Water. Effluent discharges containing chlorine are regulated under NPDES permits to reduce the impact

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on water bodies. The maximum concentration of chlorine allowed in each effluent stream is set on a site-specific and use-specific basis, to achieve the lowest possible concentrations of chlorine in each receiving stream. No significant adverse effects to aquatic organisms are anticipated from discharges of chlorine under the NPDES permitting system.

### **Endangered Species**

If acute levels of concern are exceeded in receiving waters from facilities using chlorine, a significant risk to endangered aquatic organisms can be expected. EPA is working with the U.S. Fish and Wildlife Service to develop a program to avoid jeopardizing the continued existence of identified species by the use of pesticides. When this program goes into effect, endangered species labeling may be required.

### **Additional Data Required**

The generic data base for chlorine is substantially complete to characterize acute risks. For the majority of exposure scenarios, enough data exists to adequately characterize chronic risks, also. Regarding the drinking water treatment use, although the quality of data is sufficient to reregister this public health use, there is some uncertainty regarding the health effects of halogenated byproducts that may be present. The Agency will be requiring the submission of reproductive and developmental studies on bromidichloromethane, dichloroacetic acid, and dibromoacetic acid. The Agency also is requiring product-specific data, including product chemistry, as well as revised Confidential Statements of Formula (CSF) and revised labeling for reregistration.

### **Product Labeling Changes Required**

All end-use products containing chlorine must comply with EPA's current regulations and labeling requirements. The table containing the specific labelling requirements is included in the RED document and as a supplement to this Fact Sheet. It specifies detailed labeling requirements and guidance, covering the following areas:

- **Use Directions** - The end use label must indicate specific intended uses, and must provide specific directions for each use. Products must be labeled for restricted use sites or general use sites, not both. The standard Precautionary Statements and Statement of Practical Treatment have been reworded (please see the RED).
- **Standard Labeling for Chlorine Products** - Please see the RED for exact label language pertaining to:
  - The Restricted Use Pesticide legend and usage paragraphs;
  - Statement of Practical Treatment/First Aid;

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- Precautionary Statements/Hazards to Humans and Domestic Animals (includes Personal Protective Equipment requirements);
  - Environmental Hazards;
  - Chemical and Physical Hazards;
  - Directions for Use;
  - Spill and Leak Procedures;
  - Storage and Disposal;
  - Disposal of Container.
- **Guidance for Specific Directions for Use** - See the RED for guidance and sample directions, including:
    - What specific directions for use should include;
    - Use directions for swimming pool water treatment products;
    - Directions for treating sewage and waste water;
    - Directions for control of microbiological slimes in cooling towers or pulp and paper mill process water systems;
    - Directions for treatment of municipal water supplies;
    - Directions for treating raw fruits and vegetables;
    - Directions for various methods used for sanitization of hard, nonporous food contact surfaces;
    - Directions for treatment of other hard surfaces.
  - **Effluent Discharge Statement** - All end-use (or manufacturing use) products that may be contained in an effluent discharged to the waters of the U.S. or municipal sewer systems must bear the following statement:

**"Do not use in facilities discharging directly or indirectly to the estuarine or marine environment."**

To reduce environmental risk from chlorinated water discharge and disposal, product labels must include the statements pertaining to effluent discharge under the NPDES permitting system (refer to PR Notice 93-10) and disposal under any applicable federal laws after the above statement.

## **Regulatory Conclusion**

All currently registered pesticide products containing chlorine can be used without causing unreasonable adverse effects to humans or the environment, in accordance with the revised labeling specified in this RED. Therefore, all chlorine products and uses are eligible for reregistration.

Chlorine products registered for use in non-residential swimming pools, pulp and paper mill processes, and industrial food processing plants are being reclassified as Restricted Use Pesticides due to chlorine's extreme acute

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toxicity plus many associated human poisoning incidents. These products must bear Restricted Use Pesticide labeling no sooner than October 1, 2000, and no later than April 1, 2001.

Chlorine products registered for drinking water, sewage and wastewater treatment uses and residential pool use will remain classified for general use because few related accidents or incidents have been reported. Additionally for water treatment, applicators already are trained and certified by the states to perform these uses.

Products containing chlorine as the sole active ingredient will be reregistered once the required product-specific data, CSF and revised labeling are received and accepted by EPA. Products containing other active ingredients will be reregistered only after the other active ingredients also are determined to be eligible for reregistration.

## **For More Information**

EPA is requesting public comments on the Reregistration Eligibility Decision (RED) document for Chlorine Gas, during a 60-day time period, as announced in a Notice of Availability published in the Federal Register. To obtain a copy of the RED document or to submit written comments, please contact the Pesticide Docket, Information and Record Integrity Branch, Information Resources Services Division (7502C), Office of Pesticide Programs (OPP), US EPA, Washington, DC 20460, telephone 703-305-5805.

Electronic copies of the RED and this fact sheet are available on the internet. See <http://www.epa.gov/REDs>.

Printed copies of the RED and fact sheet can be obtained from EPA's National Center for Environmental Publications and Information (EPA/NCEPI), PO Box 42419, Cincinnati, OH 45242-0419, telephone 513-489-8190, fax 513-489-8695.

Following the comment period, the Chlorine Gas RED document also will be available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, telephone 703-605-6000 or 800-553-6847.

For more information about EPA's pesticide reregistration program, the Chlorine Gas RED, or reregistration of individual products containing chlorine gas, please contact the Special Review and Reregistration Division (7508W), OPP, US EPA, Washington, DC 20460, telephone 703-308-8000.

For information about the health effects of pesticides, or for assistance in recognizing and managing pesticide poisoning symptoms, please contact the National Pesticides Telecommunications Network (NPTN). Call toll-free 1-800-858-7378, between 9:30 am and 7:30 pm Eastern Standard Time, Monday through Friday.