



# Right to Know Hazardous Substance Fact Sheet

Common Name: **CAPROLACTAM**

Synonyms: 1,6-Hexolactam; 2-Oxohexamethyleneimine

Chemical Name: 2H-Azepin-2-One, Hexahydro-

Date: December 2005 Revision: November 2010

CAS Number: 105-60-2

RTK Substance Number: 0337

DOT Number: NA 3082

## Description and Use

**Caprolactam** is a white flake or crystalline (sand-like) solid with an unpleasant odor. When molten, it is a colorless or milky-white liquid. It is used to make synthetic fibers, plastics, coatings and polyurethanes.

- ▶ **ODOR THRESHOLD = 0.064 ppm**
- ▶ Odor thresholds vary greatly. Do not rely on odor alone to determine potentially hazardous exposures.

## Reasons for Citation

- ▶ **Caprolactam** is on the Right to Know Hazardous Substance List because it is cited by ACGIH, DOT, NIOSH, IARC, IRIS and EPA.

SEE GLOSSARY ON PAGE 5.

## FIRST AID

### Eye Contact

- ▶ Immediately flush with large amounts of water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while rinsing.

### Skin Contact

- ▶ Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of water.

### Inhalation

- ▶ Remove the person from exposure.
- ▶ Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped.
- ▶ Transfer promptly to a medical facility.

## EMERGENCY NUMBERS

Poison Control: 1-800-222-1222

CHEMTREC: 1-800-424-9300

NJDEP Hotline: 1-877-927-6337

National Response Center: 1-800-424-8802

EMERGENCY RESPONDERS >>>> SEE LAST PAGE

## Hazard Summary

Hazard Rating	NJDOH	NFPA
HEALTH	2	-
FLAMMABILITY	1	-
REACTIVITY	0	-
POISONOUS GASES ARE PRODUCED IN FIRE		

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

- ▶ **Caprolactam** can affect you when inhaled.
- ▶ Contact can irritate and burn the skin and eyes.
- ▶ Inhaling **Caprolactam** can irritate the nose, throat and lungs.
- ▶ Exposure to very high levels of **Caprolactam** may cause headache, irritability, confusion and convulsions (seizures).

## Workplace Exposure Limits

NIOSH: The recommended airborne exposure limit (REL) is **1 mg/m<sup>3</sup>** (as the *solid Caprolactam*) averaged over a 10-hour workshift and **3 mg/m<sup>3</sup>** (as the *solid Caprolactam*), not to be exceeded during any 15-minute work period.

NIOSH: The recommended airborne exposure limit (REL) is **0.22 ppm** (as the *vapor*) averaged over a 10-hour workshift and **0.66 ppm** (as the *vapor*), not to be exceeded during any 15-minute work period.

ACGIH: The threshold limit value (TLV) is **5 mg/m<sup>3</sup>** (as the *inhalable fraction and vapor*) averaged over an 8-hour workshift.

## Determining Your Exposure

- ▶ Read the product manufacturer's Material Safety Data Sheet (MSDS) and the label to determine product ingredients and important safety and health information about the product mixture.
- ▶ For each individual hazardous ingredient, read the New Jersey Department of Health Hazardous Substance Fact Sheet, available on the RTK website ([www.nj.gov/health/eoh/rtkweb](http://www.nj.gov/health/eoh/rtkweb)) or in your facility's RTK Central File or Hazard Communication Standard file.
- ▶ You have a right to this information under the New Jersey Worker and Community Right to Know Act and the Public Employees Occupational Safety and Health (PEOSH) Act if you are a public worker in New Jersey, and under the federal Occupational Safety and Health Act (OSHA) if you are a private worker.
- ▶ The New Jersey Right to Know Act requires most employers to label chemicals in the workplace and requires public employers to provide their employees with information concerning chemical hazards and controls. The federal OSHA Hazard Communication Standard (29 CFR 1910.1200) and the PEOSH Hazard Communication Standard (N.J.A.C. 12:100-7) require employers to provide similar information and training to their employees.

This Fact Sheet is a summary of available information regarding the health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

## Health Hazard Information

### Acute Health Effects

The following acute (short-term) health effects may occur immediately or shortly after exposure to **Caprolactam**:

- ▶ Contact can irritate and burn the skin and eyes.
- ▶ Inhaling **Caprolactam** can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath.
- ▶ Exposure to very high levels of **Caprolactam** may cause headache and convulsions (seizures).

### Chronic Health Effects

The following chronic (long-term) health effects can occur at some time after exposure to **Caprolactam** and can last for months or years:

### Cancer Hazard

- ▶ According to the information presently available to the New Jersey Department of Health, **Caprolactam** has been tested and has not been shown to cause cancer in animals.

### Reproductive Hazard

- ▶ **Caprolactam** may decrease fertility in males and females.

### Other Effects

- ▶ Exposure to very high concentrations over many years may cause irritability and confusion.

## Medical

### Medical Testing

For frequent or potentially high exposure (half the PEL or greater), the following is recommended before beginning work and at regular times after that:

- ▶ Exam of the nervous system

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

Request copies of your medical testing. You have a legal right to this information under the OSHA Access to Employee Exposure and Medical Records Standard (29 CFR 1910.1020).

## Workplace Controls and Practices

Very toxic chemicals, or those that are reproductive hazards or sensitizers, require expert advice on control measures if a less toxic chemical cannot be substituted. Control measures include: (1) enclosing chemical processes for severely irritating and corrosive chemicals, (2) using local exhaust ventilation for chemicals that may be harmful with a single exposure, and (3) using general ventilation to control exposures to skin and eye irritants. For further information on workplace controls, consult the NIOSH document on Control Banding at [www.cdc.gov/niosh/topics/ctrlbanding/](http://www.cdc.gov/niosh/topics/ctrlbanding/).

The following work practices are also recommended:

- ▶ Label process containers.
- ▶ Provide employees with hazard information and training.
- ▶ Monitor airborne chemical concentrations.
- ▶ Use engineering controls if concentrations exceed recommended exposure levels.
- ▶ Provide eye wash fountains and emergency showers.
- ▶ Wash or shower if skin comes in contact with a hazardous material.
- ▶ Always wash at the end of the workshift.
- ▶ Change into clean clothing if clothing becomes contaminated.
- ▶ Do not take contaminated clothing home.
- ▶ Get special training to wash contaminated clothing.
- ▶ Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- ▶ Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

In addition, the following may be useful or required:

- ▶ For *solid Caprolactam* use a vacuum or a wet method to reduce dust during clean-up. DO NOT DRY SWEEP.

## Personal Protective Equipment

The OSHA Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

The following recommendations are only guidelines and may not apply to every situation.

### Gloves and Clothing

- ▶ Avoid skin contact with **Caprolactam**. Wear personal protective equipment made from material which can not be permeated or degraded by this substance. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation.
- ▶ The recommended glove material for **Caprolactam** is Neoprene.
- ▶ The recommended protective clothing material for **Caprolactam** is Tyvek®, or the equivalent.
- ▶ All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

### Eye Protection

- ▶ For *solid Caprolactam* wear eye protection with side shields or goggles.
- ▶ Wear indirect-vent, impact and splash resistant goggles when working with liquids.
- ▶ Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances.

### Respiratory Protection

**Improper use of respirators is dangerous.** Respirators should only be used if the employer has implemented a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing, and medical exams, as described in the OSHA Respiratory Protection Standard (29 CFR 1910.134).

- ▶ Where the potential exists for exposure over **1 mg/m<sup>3</sup>** (as *solid Caprolactam*) or over **0.22 ppm** (as the *vapor*), use a NIOSH approved respirator with an organic vapor cartridge and particulate N, R or P95 prefilters. Increased protection is obtained from full facepiece powered-air purifying respirators.
- ▶ Leave the area immediately if (1) while wearing a filter or cartridge respirator you can smell, taste, or otherwise detect **Caprolactam**, (2) while wearing particulate filters abnormal resistance to breathing is experienced, or (3) eye irritation occurs while wearing a full facepiece respirator. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter or cartridge. If the seal is no longer good, you may need a new respirator.
- ▶ Consider all potential sources of exposure in your workplace. You may need a combination of filters, prefilters or cartridges to protect against different forms of a chemical (such as vapor and mist) or against a mixture of chemicals.
- ▶ Where the potential for high exposure exists, use a NIOSH approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus or an emergency escape air cylinder.

## Fire Hazards

If employees are expected to fight fires, they must be trained and equipped as stated in the OSHA Fire Brigades Standard (29 CFR 1910.156).

- ▶ **Caprolactam** may burn, but does not readily ignite.
- ▶ Use dry chemical, CO<sub>2</sub>, water spray or foam as extinguishing agents.
- ▶ POISONOUS GASES ARE PRODUCED IN FIRE, including *Nitrogen Oxides* and *Ammonia*.
- ▶ Use water spray to keep fire-exposed containers cool.

### Spills and Emergencies

If employees are required to clean-up spills, they must be properly trained and equipped. The OSHA Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) may apply.

If **Caprolactam** is spilled or leaked, take the following steps:

- ▶ Evacuate personnel and secure and control entrance to the area.
- ▶ Eliminate all ignition sources.
- ▶ Absorb *molten* **Caprolactam** with fly ash, cement powder or commercial sorbent and place into sealed containers for disposal.
- ▶ Moisten *solid* spilled material first or use a HEPA-filter vacuum for clean-up and place into sealed containers for disposal.
- ▶ Ventilate and wash area after clean-up is complete.
- ▶ DO NOT wash into sewer.
- ▶ It may be necessary to contain and dispose of **Caprolactam** as a HAZARDOUS WASTE. Contact your state Department of Environmental Protection (DEP) or your regional office of the federal Environmental Protection Agency (EPA) for specific recommendations.

### Handling and Storage

Prior to working with **Caprolactam** you should be trained on its proper handling and storage.

- ▶ **Caprolactam** may react violently with a mixture of ACETIC ACID and DINITROGEN TRIOXIDE.
- ▶ **Caprolactam** is not compatible with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE); STRONG BASES (such as SODIUM HYDROXIDE and POTASSIUM HYDROXIDE); CHLORINATED HYDROCARBONS (such as METHYLENE CHLORIDE and TRICHLOROETHYLENE); and ALKALI METALS (such as LITHIUM, SODIUM and POTASSIUM).
- ▶ Store in tightly closed containers in a cool, well-ventilated area away from MOISTURE, as **Caprolactam** is hygroscopic.

### Occupational Health Information Resources

The New Jersey Department of Health offers multiple services in occupational health. These services include providing informational resources, educational materials, public presentations, and industrial hygiene and medical investigations and evaluations.

#### For more information, please contact:

New Jersey Department of Health  
Right to Know  
PO Box 368  
Trenton, NJ 08625-0368  
Phone: 609-984-2202  
Fax: 609-984-7407  
E-mail: [rtk@doh.state.nj.us](mailto:rtk@doh.state.nj.us)  
Web address: <http://www.nj.gov/health/eoh/rtkweb>

***The Right to Know Hazardous Substance Fact Sheets  
are not intended to be copied and sold  
for commercial purposes.***

## GLOSSARY

**ACGIH** is the American Conference of Governmental Industrial Hygienists. They publish guidelines called Threshold Limit Values (TLVs) for exposure to workplace chemicals.

**Acute Exposure Guideline Levels (AEGs)** are established by the EPA. They describe the risk to humans resulting from once-in-a-lifetime, or rare, exposure to airborne chemicals.

**Boiling point** is the temperature at which a substance can change its physical state from a liquid to a gas.

A **carcinogen** is a substance that causes cancer.

The **CAS number** is unique, identifying number, assigned by the Chemical Abstracts Service, to a specific chemical.

**CFR** is the Code of Federal Regulations, which are the regulations of the United States government.

A **combustible** substance is a solid, liquid or gas that will burn.

A **corrosive** substance is a gas, liquid or solid that causes destruction of human skin or severe corrosion of containers.

The **critical temperature** is the temperature above which a gas cannot be liquefied, regardless of the pressure applied.

**DEP** is the New Jersey Department of Environmental Protection.

**DOT** is the Department of Transportation, the federal agency that regulates the transportation of chemicals.

**EPA** is the Environmental Protection Agency, the federal agency responsible for regulating environmental hazards.

**ERG** is the Emergency Response Guidebook. It is a guide for emergency responders for transportation emergencies involving hazardous substances.

**Emergency Response Planning Guideline (ERPG)** values provide estimates of concentration ranges where one reasonably might anticipate observing adverse effects.

A **fetus** is an unborn human or animal.

A **flammable** substance is a solid, liquid, vapor or gas that will ignite easily and burn rapidly.

The **flash point** is the temperature at which a liquid or solid gives off vapor that can form a flammable mixture with air.

**IARC** is the International Agency for Research on Cancer, a scientific group.

**Ionization Potential** is the amount of energy needed to remove an electron from an atom or molecule. It is measured in electron volts.

**IRIS** is the Integrated Risk Information System database on human health effects that may result from exposure to various chemicals, maintained by federal EPA.

**LEL or Lower Explosive Limit**, is the lowest concentration of a combustible substance (gas or vapor) in the air capable of continuing an explosion.

**mg/m<sup>3</sup>** means milligrams of a chemical in a cubic meter of air. It is a measure of concentration (weight/volume).

A **mutagen** is a substance that causes mutations. A **mutation** is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

**NFPA** is the National Fire Protection Association. It classifies substances according to their fire and explosion hazard.

**NIOSH** is the National Institute for Occupational Safety and Health. It tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

**NTP** is the National Toxicology Program which tests chemicals and reviews evidence for cancer.

**OSHA** is the federal Occupational Safety and Health Administration, which adopts and enforces health and safety standards.

**PEOSHA** is the New Jersey Public Employees Occupational Safety and Health Act, which adopts and enforces health and safety standards in public workplaces.

**Permeated** is the movement of chemicals through protective materials.

**ppm** means parts of a substance per million parts of air. It is a measure of concentration by volume in air.

**Protective Action Criteria (PAC)** are values established by the Department of Energy and are based on AEGs and ERPGs. They are used for emergency planning of chemical release events.

A **reactive** substance is a solid, liquid or gas that releases energy under certain conditions.

**STEL** is a Short Term Exposure Limit which is usually a 15-minute exposure that should not be exceeded at any time during a work day.

A **teratogen** is a substance that causes birth defects by damaging the fetus.

**UEL or Upper Explosive Limit** is the highest concentration in air above which there is too much fuel (gas or vapor) to begin a reaction or explosion.

**Vapor Density** is the ratio of the weight of a given volume of one gas to the weight of another (usually *Air*), at the same temperature and pressure.

The **vapor pressure** is a force exerted by the vapor in equilibrium with the solid or liquid phase of the same substance. The higher the vapor pressure the higher concentration of the substance in air.

Common Name: **CAPROLACTAM**

Synonyms: 1,6-Hexolactam; 2-Oxohexamethyleneimine

CAS No: 105-60-2

 Molecular Formula: C<sub>6</sub>H<sub>11</sub>NO

RTK Substance No: 0337

Description: White flake or crystalline solid with an unpleasant odor, or when molten a colorless or milky-white liquid

## HAZARD DATA

Hazard Rating	Firefighting	Reactivity
<b>2 - Health</b> <b>1 - Fire</b> <b>0 - Reactivity</b> DOT#: NA 3082 ERG Guide #: 171 Hazard Class: 9 (Miscellaneous Hazardous Material)	<b>Caprolactam</b> may burn, but does not readily ignite. Use dry chemical, CO <sub>2</sub> , water spray or foam as extinguishing agents. POISONOUS GASES ARE PRODUCED IN FIRE, including <i>Nitrogen Oxides</i> and <i>Ammonia</i> . Use water spray to keep fire-exposed containers cool.	<b>Caprolactam</b> may react violently with a mixture of ACETIC ACID and DINITROEN TRIOXIDE. <b>Caprolactam</b> is not compatible with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE); STRONG BASES (such as SODIUM HYDROXIDE and POTASSIUM HYDROXIDE); CHLORINATED HYDROCARBONS (such as METHYLENE CHLORIDE and TRICHLOROETHYLENE); and ALKALI METALS (such as LITHIUM, SODIUM and POTASSIUM).

## SPILL/LEAKS

**Isolation Distance:**

Spill: 25 meters (75 feet)

Fire: 800 meters (1/2 mile)

 Absorb *molten Caprolactam* with fly ash, cement powder or commercial sorbent and place into sealed containers for disposal.

 Moisten spilled *solid* material first or use a HEPA-filter vacuum for clean-up and place into sealed containers for disposal.

DO NOT wash into sewer.

**Caprolactam** may be hazardous to the environment, especially to aquatic organisms.

## PHYSICAL PROPERTIES

<b>Odor Threshold:</b>	0.064 ppm
<b>Flash Point:</b>	257°F (125°C)
<b>LEL:</b>	1.4%
<b>UEL:</b>	8%
<b>Auto Ignition Temp:</b>	707°F (375°C)
<b>Vapor Density:</b>	3.9 (air = 1)
<b>Vapor Pressure:</b>	0.001 mm Hg at 68°F (20°C)
<b>Specific Gravity:</b>	1.02 (water = 1)
<b>Water Solubility:</b>	Highly soluble and hygroscopic
<b>Boiling Point:</b>	513°F (267°C)
<b>Melting Point:</b>	156°F (69°C)
<b>Critical Temperature:</b>	944.4°F (507°C)
<b>Molecular Weight:</b>	113.16

## EXPOSURE LIMITS

**NIOSH:** 1 mg/m<sup>3</sup> (*solid*), 10-hr TWA; 3 mg/m<sup>3</sup> STEL

**NIOSH:** 0.22 ppm (*vapor*), 10-hr TWA; 0.66 ppm STEL

**ACGIH:** 5 mg/m<sup>3</sup>, 8-hr TWA

The Protective Action Criteria values are:

 PAC-1 = 3 mg/m<sup>3</sup>    PAC-2 = 20 mg/m<sup>3</sup>

 PAC-3 = 20 mg/m<sup>3</sup>

## PROTECTIVE EQUIPMENT

<b>Gloves:</b>	Neoprene
<b>Coveralls:</b>	Tyvek® >1 mg/m <sup>3</sup> <i>solid</i> or >0.22 ppm <i>vapor</i> - full facepiece APR with <i>Organic vapor</i> cartridges and <i>N95</i> prefilters
<b>Respirator:</b>	>3 mg/m <sup>3</sup> <i>solid</i> or >0.66 ppm <i>vapor</i> - SCBA

## HEALTH EFFECTS

<b>Eyes:</b>	Irritation and burns
<b>Skin:</b>	Irritation and burns
<b>Inhalation:</b>	Nose, throat and lungs irritation with coughing, wheezing and shortness of breath Headache and convulsions (seizures)

## FIRST AID AND DECONTAMINATION

<b>Remove</b>	the person from exposure.
<b>Flush</b>	eyes with large amounts of water for at least 15 minutes. Remove contact lenses if worn.
<b>Quickly</b>	remove contaminated clothing and wash contaminated skin with large amounts of water.
<b>Begin</b>	artificial respiration if breathing has stopped and CPR if necessary.
<b>Transfer</b>	promptly to a medical facility.