Aldehydes and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless gases with an irritating odor, or colorless-to-light brown solutions with a faint almond odor. Used as fumigants, disinfectants, germicides, preservatives, embalming fluids, cleaning products, preservatives, and in the manufacture of various plastic and resin products. An important laboratory reagent and process chemical. Formalin is a 37% formaldehyde solution with 0.5% to 15% methanol added to prevent polymerization.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Eyes
Skin
Respiratory system
Metabolism
Secondary
Central nervous system
Cardiovascular system
Gastrointestinal system
Hepatic
Renal

LIFE THREAT
Seizures, respiratory failure, and pulmonary edema.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia, cardiovascular collapse, and hypotension.
Respiratory: Respiratory tract irritant. Upper airway edema and laryngospasm, cough, dysphagia, pulmonary edema, bronchial constriction, reactive airways disease (asthma-like) symptoms.
CNS: Headache, vertigo, seizures, CNS depression, and coma.
Gastrointestinal: Nausea, vomiting (hematemesis), diarrhea, severe mucosal necrosis, and abdominal pain.
Eye: Chemical conjunctivitis, lacrimation, and corneal damage.
Renal: Kidney damage and hematuria.
Hepatic: Liver damage and jaundice.
Metabolism: Anion gap metabolic acidosis.
Other: These products may cause olfactory fatigue and therefore not demonstrate ad-
Aldehydes and Related Compounds

Equate warning properties. Formaldehyde may present a carcinogenic risk to humans. More data are needed on products in this group.

**SYMPTOM ONSET FOR ACUTE EXPOSURE**

Immediate

Respiratory symptoms possibly delayed

**THERMAL DECOMPOSITION PRODUCTS INCLUDE**

- Carbon dioxide
- Carbon monoxide

**MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE**

- Skin or eye disorders
- Respiratory system disorders

**DECONTAMINATION**

- Wear positive-pressure SCBA and protective equipment specified by references such as the *DOT Emergency Response Guidebook* or the *CANUTEC Initial Emergency Response Guide*. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- Gently blot excess liquids with absorbent material.
- Rinse patient with warm water, 30°C/86°F, if possible.
- Wash patient with Tincture of Green Soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

**IMMEDIATE FIRST AID**

- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

**BASIC TREATMENT**

- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Aggressive airway management may be necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not
Aldehydes and Related Compounds

drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

**ADVANCED TREATMENT**

- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest. Intubation should be considered at the first sign of upper airway obstruction caused by edema.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Start an IV with D_{5}W TKO Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- For hypotension with signs of hypovolemia, administer fluid cautiously. Consider vasopressors if patient is hypotensive with a normal fluid volume. Watch for signs of fluid overload (refer to shock protocol in Section Three).
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

**INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS**

- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiographs, and electrocardiogram may be required.
- Positive end-expiratory pressure (PEEP) assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
- Bronchospastic symptoms should be treated with an inhalation medication regime similar to that used for reactive airways disease. Inhaled corticosteroids may be of value in severe bronchospasm.
- Sodium bicarbonate may be needed to correct metabolic acidosis. Administration should be guided by patient presentation, ABG determination, and serum electrolyte considerations.
- Hemodialysis may be beneficial in the severely symptomatic patient. Treatment should be guided by patient presentation and laboratory values.
- Obtain toxicological consultation as necessary.

**SPECIAL CONSIDERATIONS**

Formalin solutions may contain 0.5% to 15% methanol (refer to methanol guideline 31).
Ketones and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless organic liquids with a sharp, fragrant, acetone-type or sweet odor. Used as intermediates and solvents for inks, resins, adhesives; components of cleaning agents and paint/varnish removers. Also used in the production of numerous products, including perfumes, pesticides, and petroleum oils.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Skin
Eyes
Central nervous system
Cardiovascular system
Respiratory system
Metabolism
Secondary
Gastrointestinal system
Hepatic

LIFE THREAT
Respiratory tract (mucous membrane) irritation, pulmonary edema, and depression of CNS. Certain products (ketone peroxides) can be extremely corrosive.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia and arrhythmias.
Respiratory: Respiratory tract irritation, bronchospasm, dyspnea, pulmonary edema, and respiratory depression.
CNS: Headache, paresthesias, muscle weakness, drowsiness, dizziness, incoordination, CNS depression, coma, neurobehavioral changes, central and peripheral neuropathy.
Gastrointestinal: Nausea, vomiting, and abdominal pain.
Eye: Chemical conjunctivitis and temporary clouding of the cornea to serious, permanent damage, including blindness.
Skin: Drying of the skin, irritant dermatitis, and chemical burns.
Hepatic: Liver damage.
Metabolism: Metabolic acidosis with anion gap.
Other: Some products may cause olfactory fatigue and therefore not demonstrate adequate warning properties. Hypothermia has been reported.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Respiratory symptoms possibly delayed
Neuropathy symptoms possibly delayed
CO-EXPOSURE CONCERNS
Other hydrocarbon solvents

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Carbon dioxide
Carbon monoxide

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Eye disorders
Nervous system disorders
Respiratory system disorders

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- Gently blot excess liquids with absorbent material.
- Rinse patient with warm water, 30°C/86°F, if possible.
- Wash patient with Tincture of Green Soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask, device or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- For contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
Ketones and Related Compounds

- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with D₅W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS

- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Positive end-expiratory pressure (PEEP) assisted-ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
- Sodium bicarbonate may be needed to reduce metabolic acidosis. Bicarbonate therapy should be guided by patient presentation, ABG determination, and serum electrolyte considerations.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS

- Methyl n-butyl ketone (MBK) is a known neurotoxin. The primary metabolite of MBK, 2,5-hexanedione, produces central and peripheral neurotoxicity characterized by the dying-back axonopathy. Symptoms are usually delayed.
Naphthalene and Related Compounds

SUBSTANCE IDENTIFICATION
Found as a colorless-to-brown solid with an odor of mothballs. Used as insecticides, moth repellents, fumigants, and toilet bowl deodorants. Also used in the manufacture of phthalic anhydride, solvents, insecticides, pigments, rubber chemicals, waxes, rodenticides, and numerous other products.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Skin
Eyes
Central nervous system
Cardiovascular system
Respiratory system
Blood
Secondary
Gastrointestinal system
Hepatic
Renal

LIFE THREAT
Acute intravascular hemolysis that can be delayed for several days.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia. Hemolysis and anemia often after the third day and subsequent hypovolemia.
Respiratory: Respiratory tract irritation and mild tachypnea.
CNS: Headache, confusion, excitement, occasional coma and seizures, and neurobehavioral changes.
Gastrointestinal: Nausea, vomiting, and abdominal pain.
Eye: Chemical conjunctivitis, corneal ulcerations, cataracts, and inflammation of the optic nerve.
Skin: Irritation, diaphoresis, dermatitis, hypersensitivity dermatitis, and jaundice secondary to hemolysis. Acneiform rashes reported with chronic exposure.
Hepatic: Liver injury and jaundice.
Renal: Renal damage.
Blood: Mild methemoglobinemia. Increased white blood cell count (leukocytosis), Heinz bodies, free hemoglobin (hemoglobinemia). Acute red blood cell hemolysis, and anemia may occur.
SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Symptoms of hemolysis possibly delayed

CO-EXPOSURE CONCERNS
Chlorinated hydrocarbon solvents

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Carbon dioxide
Carbon monoxide
Chloride fumes

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Chronic anemia
Glucose-6-phosphate dehydrogenase (G6PD) deficiency

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30° C/86° F, if possible.
- Wash patient with Tincture of Green Soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).
ADVANCED TREATMENT

- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious.
- Start an IV with lactated Ringer’s. Adequate hydration must be maintained to prevent renal failure secondary to myoglobinuria unless signs of cerebral or pulmonary edema are present.
- For hypotension with signs of hypovolemia, administer fluid cautiously. Watch for signs of fluid overload (refer to shock protocol in Section Three).
- Administer 1% solution methylene blue if patient is symptomatic with severe hypoxia, cyanosis, and cardiac compromise not responding to oxygen. DIRECT PHYSICIAN ORDER ONLY (refer to methylene blue protocol in Section Four).
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS

- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Free hemoglobin, urine hemoglobin, haptoglobin, hematocrit, and bilirubin determinations are useful in assessing extent of hemolysis.
- Monitor blood methemoglobin levels and treat with methylene blue if patient is symptomatic and/or has a blood methemoglobin level greater than 30% (refer to methylene blue protocol in Section Four).
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS

- Naphthalene is metabolized to naphthol. This is an example of lethal synthesis, with the metabolite 1-naphthol responsible for the late symptoms of red blood cell hemolysis.
- Patients with glucose-6-phosphate dehydrogenase (G6PD) deficiency, a hereditary problem, are more susceptible to the hemolytic effects of 1-naphthol.
Phenols and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless-to-pink solid or thick liquid. Laboratory reagents, disinfectants, sanitizers, fumigants, and barn deodorants; and photographic chemicals. Products used in the manufacturing of plywood, electrical appliances, and automotive parts. Sometimes used as an industrial coating of drums and cans.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Skin
Eyes
Central nervous system
Cardiovascular system
Respiratory system
Gastrointestinal system
Metabolism
Secondary
Renal
Hepatic
Blood

LIFE THREAT
Coma, hypotension, cardiac arrhythmias, pulmonary edema, and respiratory arrest are common findings.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Cardiovascular collapse, hypotension, tachycardia, and arrhythmias (supraventricular and ventricular).
Respiratory: Snoring, tachypnea, shallow respirations, and pulmonary edema.
CNS: Headache, dizziness, tinnitus, weakness, confusion, and excitement, followed by coma. Seizures.
Gastrointestinal: Burns in mouth and throat, nausea, vomiting, diarrhea, hemorrhage, and abdominal pain.
Eye: Severe eye damage and blindness.
Skin: Strong corrosive effect on tissue. Pain from skin exposure is rapidly followed by numbness and blanching with severe burn. Cyanosis, pallor, sweating, hypothermia and irritant dermatitis possible.
Renal: Nephritis.
Hepatic: Liver damage, jaundice, and increases in serum aminotransferases.
Metabolism: Metabolic acidosis with anion gap.
Blood: Methemoglobinemia may be seen with some phenols.
Other: Possible mutagenic effects; may be a tumor promoter.

**SYMPTOM ONSET FOR ACUTE EXPOSURE**

Immediate
Some effects possibly delayed

**THERMAL DECOMPOSITION PRODUCTS INCLUDE**

- Carbon dioxide
- Carbon monoxide
- Nitrogen oxides
- Possibly hydrogen chloride gas

**MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE**

- Respiratory disorders (asthma, bronchitis)
- Skin disorders
- Liver disorders
- Kidney disorders

**DECONTAMINATION**

- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient's clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30° C/86° F, if possible.
- Wash patient with Tincture of Green Soap or a mild liquid soap and large quantities of water.
- Polyethylene glycol (PEG 300 or 400) may be an effective decontamination solution. Follow with soap and water wash.
- 70% Isopropanol may be an alternative decontamination solution for phenol skin contamination/burns less than 5% body surface area (BSA). For phenol burns greater than 5% BSA use PEG, since isopropanol may increase systemic absorption. Further studies are required to assess the efficacy of isopropanol for phenol dermal decontamination.
- Refer to decontamination protocol in Section Three.

**IMMEDIATE FIRST AID**

- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand valve resuscitator, bag-valve-mask, device or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

**BASIC TREATMENT**

- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
Phenols and Related Compounds

- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Administer activated charcoal (refer to activated charcoal protocol in Section Four). Dilution may be contraindicated because it may increase absorption.
- Do not use emetics (refer to ingestion protocol in Section Three).
- Cover skin burns with dry, sterile dressings after decontamination (refer to chemical burn protocol in Section Three).
- Maintain body temperature.

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with D5W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- For hypotension with signs of hypovolemia, administer fluid cautiously. Consider vasopressors for hypotension with a normal fluid volume. Watch for signs of fluid overload (refer to shock protocol in Section Three).
- Administer 1% solution methylene blue if patient is symptomatic with severe hypoxia, cyanosis, and cardiac compromise not responding to oxygen. DIRECT PHYSICIAN ORDER ONLY (refer to methylene blue protocol in Section Four).
- Treat seizures with diazepam (Valium). (refer to diazepam protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS
- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (AST and ALT), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Certain products especially dinitrophenol and hydroquinone may cause methemoglobinemia. Monitor blood methemoglobin levels and treat with methylene blue if patient is symptomatic and/or has a blood methemoglobin level greater than 30% (refer to methylene blue protocol in Section Four).
- Positive end-expiratory pressure (PEEP)–assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
- Obtain toxicological consultation as necessary.
Ethylene Oxide and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless liquid or gas with a sweet or ether-type odor. High fire and explosion hazard. Used in the tobacco industry, in the manufacture of many industrial chemicals, as fumigants, and as rocket propellants. Widely used in hospital sterilizers. Poor warning property: olfactory fatigue may occur early.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Eyes and skin
Respiratory system
Central nervous system
Hepatic
Renal
Secondary
Cardiovascular system
Gastrointestinal system

LIFE THREAT
Irritant to respiratory tract. Pulmonary edema.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Arrhythmias.
CNS: Headache, drowsiness, slurred speech, weakness, dizziness, incoordination, ataxia, nystagmus. Loss of taste and smell, syncope, seizures, and peripheral neuropathy may be seen. Neurobehavioral changes possible.
Gastrointestinal: Nausea, protracted vomiting, and abdominal pain may be present.
Eye: Chemical conjunctivitis, corneal damage, cataract formation.
Skin: Irritation to contact dermatitis with vesicular eruptions, chemical burns, frostbite, and cyanosis may be seen.
Renal: Kidney damage.
Hepatic: Liver damage.
Other: Ethylene oxide may present a carcinogenic and mutagenic risk to humans. Allergic reactions.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms, especially respiratory, possibly delayed
THERMAL DECOMPOSITION PRODUCTS INCLUDE
Carbon dioxide
Carbon monoxide
Irritating vapors

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory disorders (asthma, bronchitis)
Nervous system disorders
Skin disorders

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- Gently blot excess liquids with absorbent material.
- Rinse patient with warm water, 30°C/86°F, if possible.
- Wash patient with Tincture of Green Soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).
- Cover skin burns with dry sterile dressings after decontamination (refer to chemical burn protocol in Section Three).
- Treat frostbite with rapid rewarming techniques (refer to frostbite protocol in Section Three).

**ADVANCED TREATMENT**
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or has severe pulmonary edema.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with D$_3$W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

**INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS**
- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Positive end-expiratory pressure (PEEP)-assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
- Obtain toxicological consultation as necessary.

**SPECIAL CONSIDERATIONS**
- Ethylene oxide has been reported to cause chromosomal changes and sister chromatid exchanges and increase the spontaneous abortion rate. Studies continue on these effects.
- Exposed individuals may require genetic/reproductive counseling. Ethylene oxide medical surveillance programs should be instituted for individuals who may have potential occupational exposure.
Polychlorinated Biphenyls (PCBs), Polybrominated Biphenyls (PBBs), Polychlorinated Dibenzofurans (PCDFs), and Related Compounds

SUBSTANCE IDENTIFICATION
Found as a straw-colored liquid. Used as petroleum additives; dielectric (cooling fluid) in capacitors/transformers, investment cast processes, and hydraulic and heat exchange fluids; ingredients in inks, adhesives, and paints. Also used in insulation for electric cables/wire, coatings for foundry use, fire retardants, and thermoplastic manufacture. Products are no longer produced in or imported into the United States. PCBs and PBBs may be found contaminated with PCDFs or polychlorinated dibenzodioxins (dioxin), which may be responsible for the carcinogenic and reproductive hazard.

ROUTES OF EXPOSURE
- Skin and eye contact
- Inhalation
- Ingestion
- Skin absorption

TARGET ORGANS
Primary
- Skin
- Eye
- Central nervous system
- Hepatic
Secondary
- Cardiovascular system
- Respiratory system
- Gastrointestinal system

LIFE THREAT
Acute and chronic exposure can cause liver and kidney damage.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Hypertension.
Respiratory: Irritation of the respiratory tract.
CNS: Transient visual disturbances, headache, and fatigue.
Gastrointestinal: Irritation of the mucous membranes, anorexia, abdominal pain, and nausea.
Eye: Chemical conjunctivitis, increased eye discharge, and swelling of the eyelids.
**Skin:** Acneform dermatitis (chloracne) and edema of the face and hands.

**Hepatic:** Liver damage with or without jaundice, hypercholesterolemia, and hypertri-glyceridemia have been observed.

**Other:** Products may present a human carcinogenic and reproductive risk (controversial) in humans.

**SYMPTOM ONSET FOR ACUTE EXPOSURE**
Most symptoms delayed

**CO-EXPOSURE CONCERNS**
Carbon tetrachloride

**THERMAL DECOMPOSITION PRODUCTS INCLUDE**
Polychlorinated dibenzo-para-dioxins (PCDDs)
Polychlorinated dibenzofurans (PCDFs)
Chloride fumes

**MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE**
Central nervous system disorders
Liver disorders

**DECONTAMINATION**
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient's clothing, jewelry, and shoes.
- Gently blot excess liquids with absorbent material.
- Rinse patient with warm water, 30°C/86°F, if possible.
- Wash patient with Tincture of Green Soap or a mild liquid soap and large quantities of water.
- Products may be extremely difficult to remove from the skin. Multiple washes may be necessary.
- Refer to decontamination protocol in Section Three.

**IMMEDIATE FIRST AID**
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

**BASIC TREATMENT**
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
PCBs, PBBs, PCDFs, and Related Compounds

- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).
- Cover skin irritation with dry sterile dressings after decontamination.

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in severe respiratory distress.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with lactated Ringer’s TKO. Watch for signs of fluid overload.
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS
- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Following massive acute exposure, PCB serum concentrations may be helpful in assessing absorption. Adipose tissue biopsy measurements are more useful in evaluation of chronic exposures.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS
- Since most signs and symptoms will be delayed, exposures will need little acute therapy. Treatment should be aimed at decontamination and emergency care of the eyes.
- Medical counseling for exposure victims concerning reproductive and carcinogenic risk is beneficial.