International Association of Fire Fighters

Emergency Response to Chemical Process Industries

Student Manual

Version 1.0

Developed by

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Course Description

The *Emergency Response to Chemical Process Industries* course is a one-day student-centered, instructor-led training. The activities are designed by first responders, for first responders, to address key issues related to their health and safety at chemical process industry incidents. A special cadre of IAFF master instructors selected from the IAFF's instructor team has been trained to deliver the course. All emergency response personnel are encouraged to attend.

The overall goal of the program is to train first responders to use Analyze, Plan, Implement and Evaluate (APIE): A Risk-Based Response Process to effectively respond to incidents involving the chemical process industry, and reduce responder injury and death. The purpose of the course is to help decrease the number of injuries and deaths of emergency response personnel responding to chemical process industry incidents.

This course also gives first responders the opportunity to learn new strategies they can use to help decrease injury and death in their departments. Topics include pre-incident planning, as well as the specific actions for each step in APIE: A Risk-Based Response Process.

Attending this training satisfies most of the annual hazardous materials refresher requirements as stated in OSHA 1910.120 Hazardous Waste Operations and Emergency Response (HAZWOPER). However, 1910.120 (q)(6)(ii) requires that the employer certify that an individual has met all of the requirements and competencies identified under 1910.120(q)(6)(i) and 1910.120 (q)(6)(ii). It is still the responsibility of the employer/department to ensure that all competencies are met. Examples of additional information that needs to be covered include: how to perform basic control containment and confinement, as well as ensuring the employee has an understanding of the relevant standard operating procedures/guidelines (SOPs/SOGs).

Development and delivery of the course is funded in whole by a grant from the Occupational Safety and Health Administration (OSHA), United States Department of Labor (DOL). The goal of OSHA is to enhance the safety and health of emergency responders and reduce occupational hazards.

For more information on this program, contact:

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Course Goals and Objectives

This course allows you to analyze catastrophic incidents in the chemical process industry and the special problems these incidents present for emergency response personnel. Detailed case studies provide examples of the types of catastrophic incidents that can occur in chemical plants, why they happen, how they differ from ordinary fire and hazardous materials (hazmat) incidents, and how they should be managed.

The case histories that are presented in the following lessons and modules illustrate some of the recent catastrophic events that have occurred in the chemical industry. Comprehensive case histories are hard to find; those that are available most often cover the event briefly, with no mention of the risks and problems encountered by local emergency responders. Thus, the cases presented here contain little specific information about the risks to fire fighters. Keep this fact in mind when reading them, and consider how the events described would have affected responders from local fire departments.

Course Goals

The International Association of Fire Fighters (IAFF) will train first responders to use APIE: A Risk-Based Response Process during responses to incidents involving the chemical process industry, and reduce responder exposure, injury and death, as well as protect other lives, property and the environment.

Terminal Objectives

Given case studies/scenarios of chemical process industry emergencies, you will use APIE: A Risk-Based Response Process and the APIE Worksheet to identify the actions first responders should take to:

1. Analyze the problem
2. Plan the response
3. Implement the plan
4. Evaluate the progress

If you apply what you learn in this course, your actions may help decrease the number of injuries and fatalities experienced by first responders.

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Module 1:

Introduction

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Module 1 – Introduction

Module 1 Objectives

After completing this module, you will be able to identify:

- The definition of chemical process industry
- The reasons incidents at chemical facilities are often more dangerous than other hazmat incidents
- Key regulations related to the chemical process industry
- The importance of pre-incident planning
- The types of chemical process industry sites and incidents
- The purpose of, and steps in, APIE: A Risk-Based Response Process

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Definition of Chemical Process Industry

Use the space below to write your definition of the chemical process industry.

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A Chemical Process Industry Incident

The chemical industry has been generally regarded as safe, and many individual companies have developed strong safety and health programs. However, serious incidents and catastrophic events involving hazmat have occurred infrequently, but regularly, in the United States and the rest of the world.

Typical examples are major fires, explosions and releases of toxic materials that have killed and injured significant numbers of people working in the plants and living in surrounding communities, and caused environmental damage at the same time. Although the exact numbers are not known, chemical process industry incidents cause a significant number of worker fatalities and injuries or illness every year. And, while there are no statistics of injuries/illness among the general public as the result of major incidents involving hazmat, it is definitely impacted as well.

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Major Chemical Process Industry Incidents

Specific information on major incidents in the chemical industry is scarce with no summaries of major incidents in the United States or abroad readily available. The list below represents some of the major incidents that occurred during the past twenty years[1, 2]:

Date	Facility	Location	Type of Incident	Injuries/Fatalities
10/89	Phillips	Houston, TX	Explosion	23 killed, 130 injured
7/90	ARCO	Channel View, TX	Explosion	17 killed
8/95	FMC Corp.	Tonawanda, NY	Fire (Persulfate)	1 killed
10/97	Pesticide repackaging plant	West Helena, AR	Fire	3 killed, 16 injured
9/01	AZF Fertilizer	Toulouse, France	Explosion	29 killed, 10,500 injured (2,500 seriously wounded and 8,000 light injuries), 40,000 homeless
11/03	DPC Enterprises	Glendale, AZ	Release (Chlorine)	14 injured
3/05	BP Refinery	Texas City, TX	Explosion and fire	15 killed, 180 injured
2/08	Imperial Sugar Refinery	Port Wentworth, GA	Explosion and fire	13 killed, 42 injured

This is by no means a complete list for the period, but it represents a total of 72 fatalities and 382 injuries in the United States alone. Most of these victims were workers, however the West Helena and Glendale incidents illustrate that emergency response personnel are also at serious risk when catastrophic events involving hazardous substances occur. All of the incidents listed above involved some type of chemical process industry.

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[1] Accidental Release Prevention Requirements; Risk Management Programs Under Clean Air Act Section 112(r)(7); Amendments. Federal Register Environmental Documents, EPA.gov. January 21, 2009. <http://www.epa.gov/EPA-AIR/1999/January/Day-06/a99231.htm>

[2] Belke, James C. Chemical accident risks in United States industry - A preliminary analysis of accident risk data from United States hazardous chemical facilities. EPA. Washington, D.C. September 25, 2000.

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Hazards at Chemical Process Industry Incidents

For fire fighters and other emergency responders, major incidents in the chemical industry are likely to be far more dangerous than common hazmat incidents in many other industries. This is true even though the hazmat encountered is often similar.

Team Activity

Use the space below for your notes and your team's responses on the dangers of incidents at chemical process industry sites. Discuss the following question with your team and be prepared to report back to the class.

Why are major incidents in the chemical industry often more dangerous than hazmat incidents in other industries?

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Bhopal, India Case Study

In the early morning hours of December 3, 1984, approximately 30 to 40 tons of methyl isocyanate (MIC) escaped from an insecticide plant located outside the city of Bhopal, India. The leak began at about 12:15 a.m. and continued over a period of two to three hours. The vapor plume drifted into the surrounding community where it exposed over 500,000 people to toxic gases, initially killing at least 3,000 people. Today, the estimated number of people injured ranges from 200,000 to 600,000, with a common estimate of 520,000.[1] From published reports, local emergency responders were not called and were not notified of the release. The community had no pre-incident plan, and local authorities had no information on the identity or the hazards of the chemicals used in the plant. Emergency medical facilities in the city did not know the identity of the toxic material for at least 24 hours after the accident.[2]

The plant manufactured a carbamate insecticide known by the trade names Carbaryl and Sevin. In the process, chlorine was reacted with carbon monoxide to form phosgene. The phosgene was then reacted with monomethylamine in a chloroform solution to form MIC. The MIC was stored as an intermediate product. As needed, it was reacted with alpha naphthol to make the carbamate insecticide.

MIC is a highly reactive, unstable, flammable, volatile and toxic liquid that boils at 102°F. It reacts with water, acid, alkali, many organic chemicals and itself. These chemical reactions are exothermic (they give off heat). The rate of these reactions is temperature-dependent; that is, the higher the temperature, the faster the reaction rate. For example, at room temperature, the reaction between water and MIC is slow, but produces heat. If this heat is not removed by some type of cooling system, the temperature of the reaction mixture will increase. As the temperature of the reaction mixture rises, the rate of reaction increases, producing more heat and further increasing the reaction rate. At some point, the reaction mixture will become so hot that it will vaporize. If this reacting mixture is in a closed container, the resulting pressure and temperature can cause a violent explosion.

On the night of the incident, a storage tank containing about 11,000 gallons of MIC was contaminated by a water leak. The water set off a runaway, exothermic reaction in the MIC storage tank that raised the temperature and pressure inside the tank. The increasing temperature further increased both the rate of the runaway reaction and the temperature and pressure in the tank. In a short time, a rupture disk (a pressure relief device) opened and released the contents of the tank to an environmental safety system that failed to function. From the failed environmental safety system, the MIC moved out and up through piping, directly to the atmosphere above the plant. Conditions in the tank were estimated to be above 200 pounds per square inch (psi) and 400°F at the height of the reaction.

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[1] United States Environmental Protection Agency. Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act, Section 112(r)(7), Federal Register, June 20, 1996.

[2] United States Environmental Protection Agency. Accidental Release Prevention Requirements; Risk Management Programs Under Clean Air Act Section 112(r)(7); Amendments. Federal Register Environmental Documents, EPA.gov. January 21, 2009. <http://www.epa.gov/EPA-AIR/1999/January/Day-06/a99231.htm>

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The environmental safety system consisted of a caustic scrubber and a flare tower. The caustic scrubber was a vessel in which a circulating sodium hydroxide solution was supposed to react with, and remove MIC. The system was designed so that any gases passing through this scrubber would travel through piping to the flare tower, where any remaining MIC would be burned. On the night of the incident, neither of these safety systems was operational. The main caustic circulation pump on the scrubber would not start, and the spare caustic circulation pump had been removed for maintenance. The flare tower had been shut down for several months, and a portion of the pipe system leading to it had been removed for repair.

As an additional safeguard, a 30-ton refrigeration system had been built into the MIC storage tanks. Its purpose was to keep MIC tank temperatures at about 32°F to remove any heat buildup from unwanted chemical reactions. However, several months before the incident, the refrigeration system was shut down and drained of refrigerant. As a last resort, a water spray system had been constructed above the plant to knock down escaping vapors. It was activated on the night of the accident, but the water spray did not reach the level of the gas release and was not effective.[1]

It is not known exactly how water got into the MIC storage tank. One detailed report indicates the water entered the tank as the result of a combination of leaky valves and poor operating practices.[2] The company management says that the introduction of 1,000 - 2,000 pounds (120 - 240 gallons) of water inadvertently or deliberately initiated the reaction and caused the polymerization process that led to the release. Company management does not dispute the safety system failures mentioned above.[3]

The runaway reaction probably produced other vapors and gases, such as hydrogen cyanide (HCN), carbon monoxide (CO) and carbon dioxide (CO_2), but the major air contaminant that drifted into Bhopal was MIC. MIC has been described as ravenously reactive. Survivors reported that the vapor cloud gave off extreme heat and had a pungent odor. Initial symptoms were severe irritation and corrosion of the tissues of the eyes, nose and throat, coughing, and a choking sensation. Some died within a few minutes due to destruction of the tissues lining the respiratory system, resulting in respiratory failure. Vomiting, blindness and involuntary urination and defecation were common responses. Other symptoms reported were panic, depression, confusion, agitation, apathy and convulsions.[4]

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[1] United States Environmental Protection Agency. Accidental Release Prevention Requirements; Risk Management Programs Under Clean Air Act Section 112(r)(7); Amendments. Federal Register Environmental Documents, EPA.gov. January 21, 2009. <http://www.epa.gov/EPA-AIR/1999/January/Day-06/a99231.htm>

[2] Same as above.

[3] Belke, James C. Chemical accident risks in United States industry - A preliminary analysis of accident risk data from United States hazardous chemical facilities. EPA. Washington, D.C. September 25, 2000.

[4] United States Environmental Protection Agency. Risk Management Programs for Chemical Accidental Release Prevention, Federal Register, October 20, 1993 and January 31, 1994.

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Symptoms of fever, burning sensations in the body, loss of appetite, numbness and tingling in the limbs, giddiness and anxiety attacks appear to have manifested three to four years after the incident.[1] In fact, many of those who survived the initial incident were found to have long-term health effects, including impaired lung function, body aches, impaired vision and neurological symptoms. The neurological symptoms to date include headaches, disturbed balance, depression, fatigue and irritability. Abnormalities and problems with the gastrointestinal, musculoskeletal, reproductive and immunological systems were also frequently found in survivors of the incident.[2] Additionally, a recent study in the Journal of the American Medical Association confirmed that the children of survivors may also be affected.[3]

Whether HCN was present in the gas mixture is still a matter of some controversy.[4,5] The presence of HCN is supported by the fact that HCN residue was discovered on the incident site.[6] Also, MIC starts breaking down to HCN at 392°F and some researchers believe that the tank temperature far exceeded this during the incident.[7] Many of the deaths and acute symptoms could be explained by HCN exposure. Some researchers believe there is a medical basis for the treatment of Bhopal gas victims with the cyanide antidote, sodium thiosulfate (NaTS).[8] Either way, having the antidote on hand at the time of the incident could have saved lives.

Exposure to low concentrations of HCN may result in a range of symptoms including headache, dizziness, throat discomfort, chest tightness, skin itching, eye irritation and hyperventilation. More substantial exposures may include severe dizziness. Exposure to a massive concentration may render an individual unconscious within seconds, and can result in rapid death or coma due to metabolic asphyxiation. Death can occur within seconds or minutes of the inhalation of high concentrations of HCN gas.[9, 10] The plant had no emergency response plan for employees or the community. There were apparently two sirens at the plant, one to warn workers and one to warn the public. The International Labor Organization (ILO) report[11] says that "it was not clear when the siren to warn the public was sounded; some press accounts report a delay of several hours. Even when the alarm was sounded, people affected by the gas had no idea what was happening or where they should flee."

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[1] The Wall Street Journal. Rash of Fires at Oil and Chemical Plants Sparks Growing Alarm. November 17, 1989.

[2] United States Environmental Protection Agency. Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act, Section 112(r)(7), Federal Register, June 20, 1996.

[3] Chemical and Engineering News. Plant Disasters Fuel Industry, Government Concern over Safety. October 29, 1990.

[4] Same as footnote 1 above.

[5] Kletz, Trevor A. What Went Wrong? Case Histories of Process Plant Disasters. Gulf Publishing Co., Houston, TX, 1985.

[6] Same as footnote 5 above.

[7] Same as footnote 1 above.

[8] Same as footnote 5 above.

[9] Same as footnote 5 above.

[10] International Labor Organization. Working Paper on Control of Major Hazards in Industry and Prevention of Major Accidents. Geneva, October 1985.

[11] United States Environmental Protection Agency. Accidental Release Prevention Requirements; Risk Management Programs Under Clean Air Act Section 112(r)(7); Amendments. Federal Register Environmental Documents, EPA.gov. January 21, 2009. <http://www.epa.gov/EPA-AIR/1999/January/Day-06/a99231.htm>

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Emergency plans for workers in the plant were poor. They were instructed to check wind indicators and run into the wind, away from the direction of the gas dispersion. However, personnel reported that most escape routes from the plant were blocked. Most plant employees escaped over an eight-foot high fence topped with barbed wire on the upwind side of the plant. Only one gate was open and gas was present there.

According to the ILO Report, the following combination of conditions led to the disaster:

- A large amount of unstable, highly reactive, toxic material was stored in one place –- the tanks used at Bhopal were larger than those used in the United States and other western nations.
- Environmental safety systems were not working.
- Inadequate process design, poor maintenance or dangerous operating procedures allowed water to enter the system.
- Staffing levels had been reduced, and personnel were poorly trained.
- Corporate attention to safety was insufficient.
- Labor-management disputes were reported, and management failed to respond to previous accidents and worker warnings.
- The facility failed to inform workers and the public that the plant used, produced and stored a number of hazmats.

Additional conditions from the ILO Report that led to the disaster:

- Government authorities did not take appropriate action.
- The plant was sited poorly; it was built near long-established communities.
- There was no disaster plan to notify the local community of toxic gas releases, to evacuate nearby communities, or to inform local hospitals what had been released.

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Chemical/Physical Properties Identification Form

Product/Chemical Names:	References Used:

Chemical and Physical Properties

Physical State/Form:		Vapor Pressure: mmHg/ATM
Flammable: Yes/No	LEL: %	UEL: %

Flash Point (Fl.P): ºF/C	Boiling Point (BP): ºF/C
Ignition (Auto) Temperature: ºF/C	

Molecular Weight (MW):		Vapor Density (VD):	
Lighter/Heavier than Air:		Volatility:	
Specific Gravity (Sp.Gr.):		Solubility (SOL):	
Corrosive: pH		Reactive (with):	
Polymerization (potential): Yes/No			
Radioactive: Yes/No	Alpha:	Beta:	Gamma:

Health

Toxic: Yes/No	Routes of Exposure:

Exposure Limits:	TLV-TWA:	TLV-STEL:
TLV-C:	PEL:	IDLH:
Comments:		

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Use the space below for your responses related to the Bhopal incident.

1. **What do you think would have happened if the Bhopal Fire Department (or your department) had received an urgent call from the plant for assistance?**

   ____

   ____

   ____

   ____

   ____

   ____

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Use the space below for your responses related to the Bhopal incident.

2. **From the standpoint of the fire department, what are some of the things you would like to see on a pre-incident plan if the Bhopal plant were in your city?**

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Outcomes of Chemical Process Industry Incidents

Catastrophic incidents are most likely to occur at facilities that make, use, process or store significant amounts of toxic, reactive, flammable or explosive substances. These facilities fall into a wide range of industry groups. Many are in Standard Industrial Classification (SIC) code 28, Chemicals and Allied Products, and SIC 29, Petroleum Refining and Related Industries. Other at-risk facilities are in industry groups that include transportation, manufacturing, natural gas and electricity production, sanitary services, farm product warehousing and wholesale trade.

Until the 1984 disaster in Bhopal, India, there was little interest in why these incidents occur, how much they cost in lives and property damage, and how they might be prevented. These catastrophic events were generally considered “acts of God.” Bhopal not only caught the attention of the world, it influenced Congress in writing the Superfund Amendments and Reauthorization Act (SARA), which became law in 1986.

The original intent of SARA was to improve hazardous waste cleanup in the United States. The incident at Bhopal led to Title III of SARA, which is also known as the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986. Title III provides community access to information on hazmat, and mandates community emergency planning.

After passage of SARA, a continuing series of catastrophic events in the chemical industry led to additional legislation. The Clean Air Act Amendments (CAAA) of 1990 includes provisions aimed at protecting both employees and the general public from accidental releases of hazardous substances. Additionally, CAAA requires the Environmental Protection Agency (EPA) and OSHA to publish rules and standards covering the prevention, detection and response to chemical process industry incidents. Additional information is provided in the Appendices on pages A-19 and A-20.

Use the space below for your responses and notes on regulations related to the chemical process industry.

Why were these laws and regulations put in place, and what are they intended to do?

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Roles and Responsibilities

What are the roles and responsibilities of EPA and OSHA as designated by the Clean Air Act Amendments?

The EPA is required to ____

____

EPA coverage is nationwide and includes public sector facilities such as water treatment plants and smaller facilities that use hazmat, such as cold storage plants and propane retailers.

OSHA is required to ____

____

The OSHA regulation tends to have higher threshold quantities, and therefore applies to relatively large facilities. OSHA also does not cover public sector facilities in 24 states.

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Additional Responsibilities

The EPA, as directed, developed a list of more than 400 chemicals called the list of Extremely Hazardous Substances (EHS). These chemicals are mostly toxic materials. A threshold planning quantity (TPQ) is included for each substance listed. The TPQ represents the amount of the substance necessary to trigger community emergency response planning. The list is included in the http://yosemite.epa.gov/oswer/lol.nsf/homepage that can be downloaded from the EPA web site at http://yosemite.epa.gov/oswer/lol.nsf/homepage.

OSHA standard, 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals, established OSHA's list of Highly Hazardous Chemicals (HHC) for facilities with the potential for a major accident. The standard defines such facilities as having activities involving flammable liquids or gases in quantities of more than 10,000 pounds (4,535.9 kg), or activities involving chemicals above specified threshold quantities (TQ) on OSHA's list of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory) – 29 CFR 1910.119.

This HHC list contains about 140 different chemicals which present a potential for a catastrophic event at or above the threshold quantity. Flammable liquids and gases are not specifically identified on the list (see the Glossary for the OSHA definitions of flammable gas and liquids). Instead, the OSHA regulation identifies high risk for fire/explosion as the presence of flammable gases or liquids on site in one location in quantities of 10,000 pounds or more.

The EPA and OSHA lists of chemicals are important to pre-incident planners because they create an orderly process for identifying the most hazardous facilities and including them in community emergency response plans. However, pre-planning for fire fighter safety cannot be based solely on the EPA or OSHA lists. For fire departments, both lists have disadvantages. For example, the threshold quantities are far too large to protect fire fighters. Both OSHA and EPA use a TQ of 10,000 pounds for propane. These numbers cannot be interpreted to mean that facilities with less than 10,000 pounds are not dangerous and do not need to be pre-planned. Obviously, 9,000 pounds of propane—or even 3,000 pounds of propane—can present as serious a risk to responders as 10,000 pounds.

A second disadvantage is that the lists are not complete. Many dangerous chemicals have not been included. A good example of a material that has been overlooked is sodium hydroxide. It is not included on either EPA or OSHA list, probably because it is not considered dangerous to the environment and it will not burn or explode. However, to a fire fighter working under emergency conditions, even a small amount of this chemical can be very dangerous because it is extremely corrosive.

A third disadvantage is that many materials that can explode or burn violently are not covered by either the OSHA or the EPA definitions of flammable gases or liquids. In the chemical industry, many materials that are outside this definition are processed in large amounts at high temperatures and pressures. Releases of these materials—especially when they are stored in large volumes or subject to high temperatures—may result in major fires and explosions.

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State and Local Requirements

Practically every community has a number of facilities using or storing materials that are on the EPA EHS, but not all present the risk of a major release or incident. Some may have relatively small amounts of hazmats on hand, or the processes may be in a low hazard category. Given a community-wide list of all chemical users, pre-incident planners must identify the facilities that present the greatest potential threat. What are the factors that make some sites worse than others? Is there a way to identify the facilities that might have a catastrophic incident?

Title III, Section 301 establishes the State Emergency Response Commissions (SERC), Regional Planning Districts and Local Emergency Planning Committees (LEPCs) that are involved with emergency response planning for extremely hazardous substances.

The SERC is responsible for supervising and coordinating the activities of the LEPCs as well as establishing procedures for receiving and processing public requests for information. The LEPCs are responsible for establishing rules and procedures for handling public requests, providing public notices and developing emergency response plans (ERPs).

Facilities are required to notify the SERC if they have any chemicals on the EHS list that exceed the designated TPQ. Facilities provide either a Tier I or Tier II form (Appendices pages A-26 to A-30). The SERC then notifies the LEPC to include the facility, if appropriate, in its comprehensive emergency plan[1].

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[1] Investigation Report: Confined Vapor Cloud Explosion. United States Chemical Safety and Hazard Investigation Board (CSB) Case Study. Report No. 2007-03-I-MA. May 2008. <http://www.chemsafety.gov/>

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Pre-Incident Planning

The objectives of pre-incident planning are to prevent and prepare for incidents. Both are important and both save lives. Hazards can be identified and plans can be prepared before life-threatening situations occur. Preparedness is not a new concept for fire fighters. For years, some fire services have conducted pre-fire plans for buildings and used these plans during drills and actual fires. These same skills are used in pre-incident planning activities for hazardous materials incidents.

All first responders should be familiar with pre-incident planning for sites in their response districts that may pose special risks in the event of emergencies. This is especially true for chemical process industry sites as the dangers posed may not always be readily evident and may cost many lives (responder and civilian) if not handled effectively and efficiently.

Pre-incident planning is a key component in first responder safety and in successfully managing chemical process industry incidents. Knowing essential information about a site's dangers (i.e., specific chemicals and processes) and safety features in advance allows first responders to plan appropriate strategy and tactics and practice those plans with all the agencies and mutual-aid companies that may respond to the incident.

There are three key reasons for pre-incident planning:

1. Pre-incident planning provides emergency response agencies with the ability to obtain information about a facility and its processes prior to an emergency, and determine strategic options for potential incidents. This can be done without the stresses of an emergency situation as it develops.

2. Timely, accurate information may be difficult to obtain during an emergency incident. Pre-incident planning provides an opportunity for responders to gather information prior to an emergency. Emergency responders should keep in mind that the pre-incident plan should ONLY serve as a guideline during an emergency incident, as when an emergency occurs, additional hazards may be present besides those present under normal conditions.

3. Pre-incident planning assists the Incident Commander (IC) to develop and implement an effective Incident Action Plan (IAP) and coordinate other responding agencies. Coordination of both on-site teams and off-site responders is often a challenge, and is especially critical at chemical process industry incidents. The availability of the necessary resources, and the time to obtain them, can also be evaluated.

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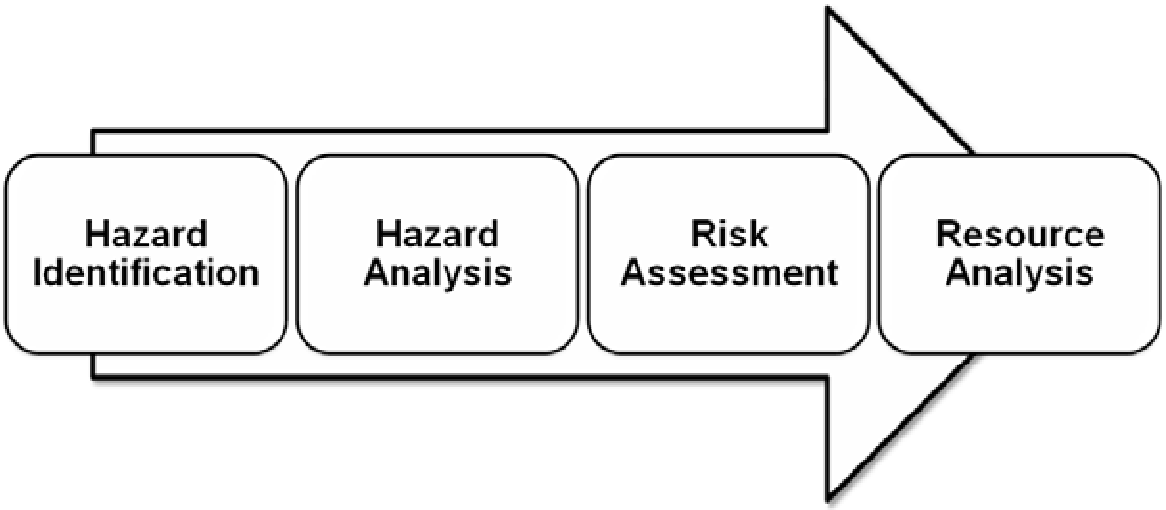
In order to plan, it is important to identify the types and locations of chemical process industry hazards within the community or jurisdiction. The next step is to analyze the hazards and assess the associated risks to determine what threat an incident would present to fire service personnel, civilians, property and the environment. Finally, determine what resources are needed for an effective response to an incident, create an inventory of those actually available, and determine how long it will take to obtain them. An effective pre-incident plan will include all of these steps or components.



Ideally, every conceivable chemical process industry site would be carefully and completely pre-planned. In reality, however, there are constraints of time, personnel and other resources that make it imperative to assess overall community problems, decide on priorities for pre-incident planning, and target specific sites or areas.

It is important to consider both fixed sites and transportation corridors when prioritizing. Responsible decision makers must identify the most acute problems and develop a schedule, timetable or a list of priorities.

When all of the potential problems within a community are considered, the task of planning may seem overwhelming. By establishing priorities and objectives, problem areas can be broken down into more manageable segments. The most severe problems or potential incidents should be addressed before less critical areas.

The right response is working within limitations of resources and training. The wrong response is going beyond those limitations.

Pre-incident plans should be tested annually through drills. They should also be updated annually. Facilities frequently change or add raw products or processes without notifying the fire department. Personnel and phone numbers change as well. Last year’s point-of-contact may no longer work at the facility.

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Pre-Incident Planning Components

Use the space below for your description of the pre-incident planning components.

1. Hazard Identification

2. Hazard Analysis

3. Risk Assessment

4. Resource Analysis

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Other Pre-Incident Planning Actions

In-House Fire Brigades and Emergency Response Teams and Plans

Use the space below to write your responses and notes related to in-house fire brigades and emergency response teams.

1. **Why are in-house fire brigades and emergency response teams such an important resource?**

2. **Why is it so important that in-house emergency plans are activated as soon as possible?**

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Prevention Plans

Under the 1990 CAAA, Congress added Section 112(r) to the statute. Section 112(r) requires owners and operators of stationary sources to identify hazards, and prevent and minimize the effects of accidental releases wherever extremely hazardous substances are present at their facility. This section was added to improve facilities' accident prevention and emergency preparedness. Some companies may have their own, which generally are the same.

Use the space below for your notes on prevention plans.

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Emergency Response Plans (ERPs)

An ERP is a plan that outlines the steps to follow in an emergency. An ERP helps to minimize panic and identifies employees and their responsibilities in an emergency situation. Emergency Response Plans are required by SERC for those facilities with substances at or above the TPQ. These plans are usually developed as a joint effort by the chemical process industry facility involved and the SERC and LEPC.

Use the space below for your notes on ERPs.

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Chemical Process Industry Checklist

Job aids, including checklists, allow you to document and consider important information related to a specific task. In this case, the Chemical Process Industry Checklist can be used to document pre-incident planning or incident information specific to the chemical process industry.

The checklist includes the following sections/information:

- **Location information** – address; building/site name; type of facility; owner's name, telephone number and/or address; emergency telephone, and cleanup contractor name and telephone number
- **Emergency response** – emergency response plan, facility incident report, emergency response team including level of training, APIE risk-based response actions, and location of incident command post and staging
- **Accountability** – number of employees, shifts, evacuation plan and locations, injuries to employees and civilians within/outside of the facility, and agencies called to assist including names and telephone numbers
- **Incident** – description, chemical/trade name(s) including level of risk and amount released, weather, site plan (facility and building diagram) including facility and building diagram
- **Building information** – specific property use, age of building, construction type, relevant features, type of roof construction, standpipe types and locations, sprinkler system locations and percent coverage, shut-off location, valves and other extinguishing systems, warning system including type, connections and alarm company information
- **Building Hazards** – common hazards (e.g., heating system, combustibles, transforms) and their locations, utilities and special hazards (e.g., chemicals, pressurized containers)
- **Hydrant locations and placement of apparatus**
- **Outside target hazards in the area to be protected/evacuated**

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Types of Chemical Process Industry Sites and Specific Hazards

Use the table below to identify the hazards first responders might encounter at each type of site.

Types of Sites	Possible Hazards
Chemical research and development	
Electronics	
Industrial chemical production	
Oil refineries	
Radiation production for products and energy use	
Synthetic production	
Specialty chemical production	
Labs at educational facilities (e.g., universities, community colleges, high schools)	

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Types of Chemical Process Industry Incidents

Incidents at chemical process industry sites may include one or more of the following:

- Fire or explosion
    - Fire in a laboratory or clean room
    - Pump seal release of flammable material that finds ignition source and ignites
    - Fire started from use of cutting torch with flammable conditions present
    - Fire started from static spark or electricity during transfer of products without grounding and bonding in place
- Release—solid, liquid or gas
    - Leak from truck making delivery to facility
    - Release in a laboratory or clean room
    - Pump seal release of flammable/toxic material
    - Product transferred to tank or vessel not certified to handle that product
        - Tank or vessel has failed and is leaking

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- Confined space
    - Failure to recognize permit-required confined spaces (29 CFR 1910.146) and follow proper procedure
    - Use of chemical in confined space during maintenance operations that has created a flammable and/or toxic vapor in space
    - Workers working in confined space without ventilation overcome due to lack of oxygen
    - Use of cutting torch in a confined space that is not removed after use
        - Leaking acetylene gas into a confined space ignites, causing an explosion
    - Failure to isolate the confined space
        - Product is leaking into the space
        - Failure to use lockout/tagout procedures (see 29 CFR 1910.147 regarding the standard for lockout/tagout)
        - Electrical energy not de-energized
- Reactive chemicals
    - Product transferred to tank that already has incompatible product in tank, creating a flammable and/or toxic vapor
    - Over-pressurization caused from mixing of chemicals, causing an explosion and vessel failure
    - Storage of chemicals in containers made of incompatible materials
    - Reaction caused by damage to several containers of incompatible products

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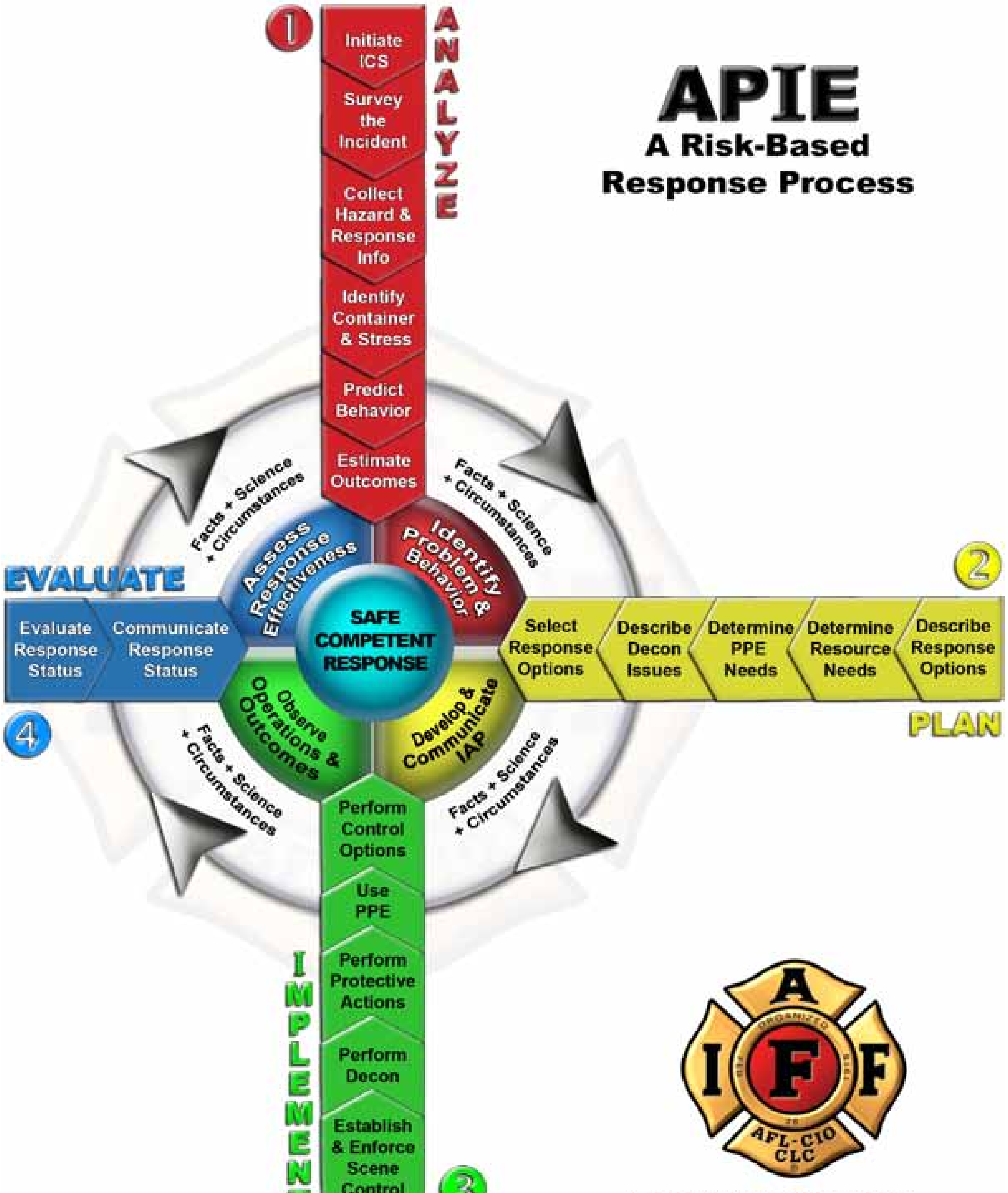
APIE: A Risk-Based Response Process Introduction

The goal of Analyze, Plan, Implement and Evaluate (APIE): A Risk-Based Response Process is safe, competent response aimed at mitigating emergencies while minimizing hazards that can result in exposure, injury and fatalities. Responders should consider the facts, science and the circumstances at each step, and take actions or make decisions based on risk-benefit analysis.



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APIE: A Risk-Based Response Process has four steps to help you work through an incident.

- **A**nalyze the problem
- **P**lan the response
- **I**mplement the plan
- **E**valuate the progress

When you use the APIE process, you begin by analyzing the problem with the goal of identifying the problem and the likely behavior of the hazmats and containers present. For the remainder of this course, you will learn to **ANALYZE** clues that indicate when and where dangerous chemicals may be present at an incident. With practice interpreting and predicting how these chemicals might act, you will become increasingly proficient in identifying the exact cause of a problem, and then relating the cause to the type of harm that could result as a consequence. This course teaches how to make those connections, and quickly draw conclusions that will protect lives of both responders and civilians, property and the environment.

The types of harm that can result from a hazardous material incident and the routes of entry of a toxic material must be taken into consideration. They can enter through inhalation (the easiest and most common), ingestion, injection or absorption. This dictates the appropriate type of personal protective equipment (PPE) required for your protection. Typical fire fighter protective clothing does not provide sufficient protection to guard against most chemicals, so at times your **PLAN** to improve the emergency situation will include seeking additional resources. The goal of the planning step is to develop an IAP that identifies the incident priorities and objectives and communicate the IAP to responders.

Once you know available responders are trained for the tasks they will perform, prepared for the hazards present, and appropriately equipped, you will be ready to **IMPLEMENT** the planned response actions to stabilize the incident. During implementation, the goal is to observe operations and outcomes.

Chemical process industry incidents are dynamic, so the tactics may need to be adjusted according to ongoing **EVALUATION** of the progress. The goal of evaluation is to assess response effectiveness. The evaluation process is always critical. If the incident is not stabilizing or is increasing in intensity, the plan's strategy and tactics may have to be changed to prevent additional harm to life, property and the environment. Remember that emergency responders are there to produce a more favorable outcome.

The APIE process is not necessarily linear; any or all steps may need to be repeated. The process is systematic but does not always progress in clear-cut, linear steps. Rather, the steps often overlap and occur simultaneously. For example, the analysis and planning steps may merge; the implementation and evaluation steps may need to be repeated.

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APIE Steps and Goals

Use the space below to identify the steps in the APIE process, and for your notes on the goals for each step.

What is the first step in the APIE process and what is its goal?

Step 1: ____

What is the goal of Step 1?

____

____

What is the second step in the APIE process and what is its goal?

Step 2: ____

What is the goal of Step 2?

____

____

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Use the space below to identify the steps in the APIE process and for your notes on the goals for each step.

What is the third step in the APIE process and what is its goal?

Step 3: ______________________________

What is the goal of Step 3?

____

____

What is the fourth step in the APIE process and what is its goal?

Step 4: ______________________________

What is the goal of Step 4?

____

____

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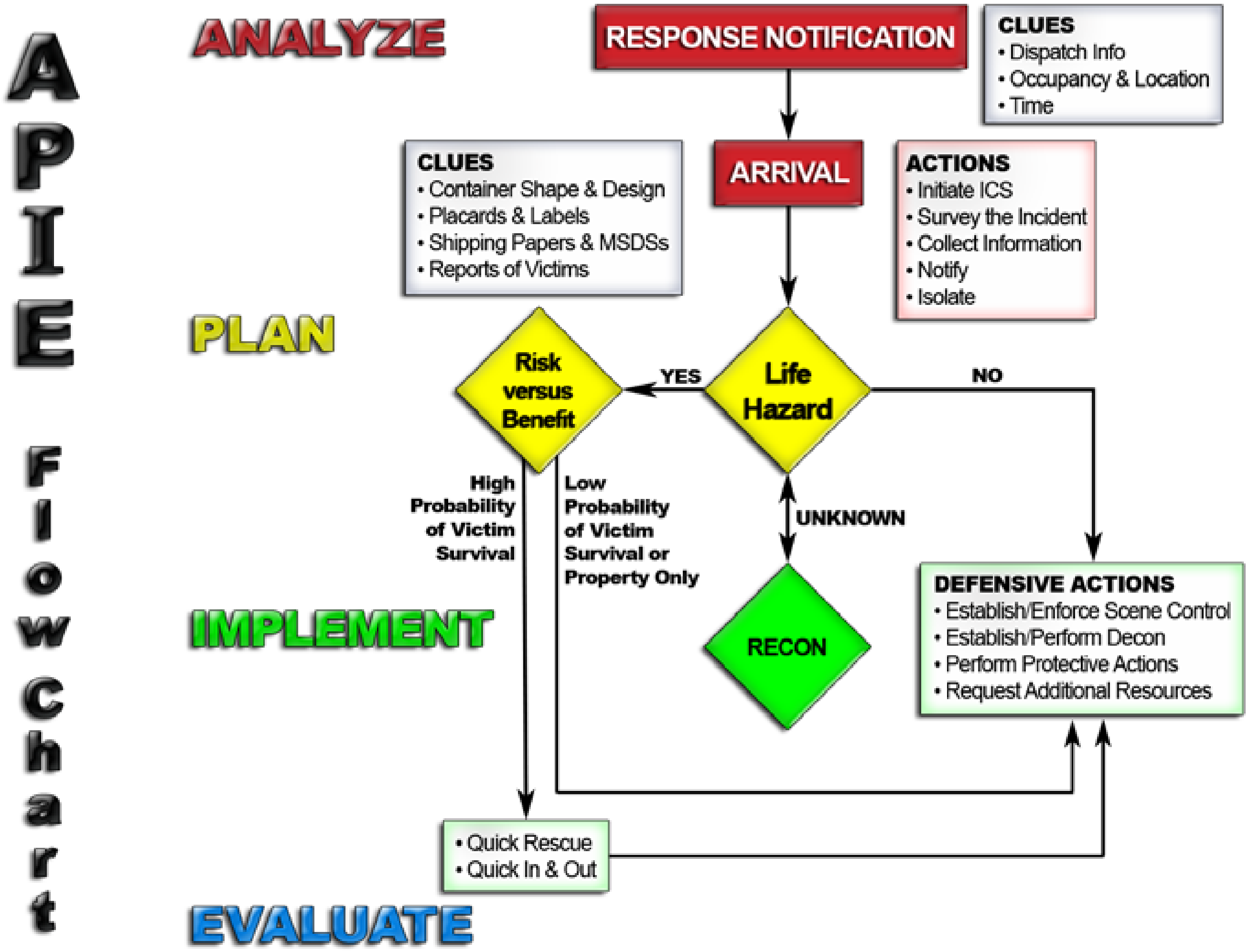
Flow Chart for APIE: A Risk-Based Response Process



In which types of situations can the APIE process be a useful incident management tool?

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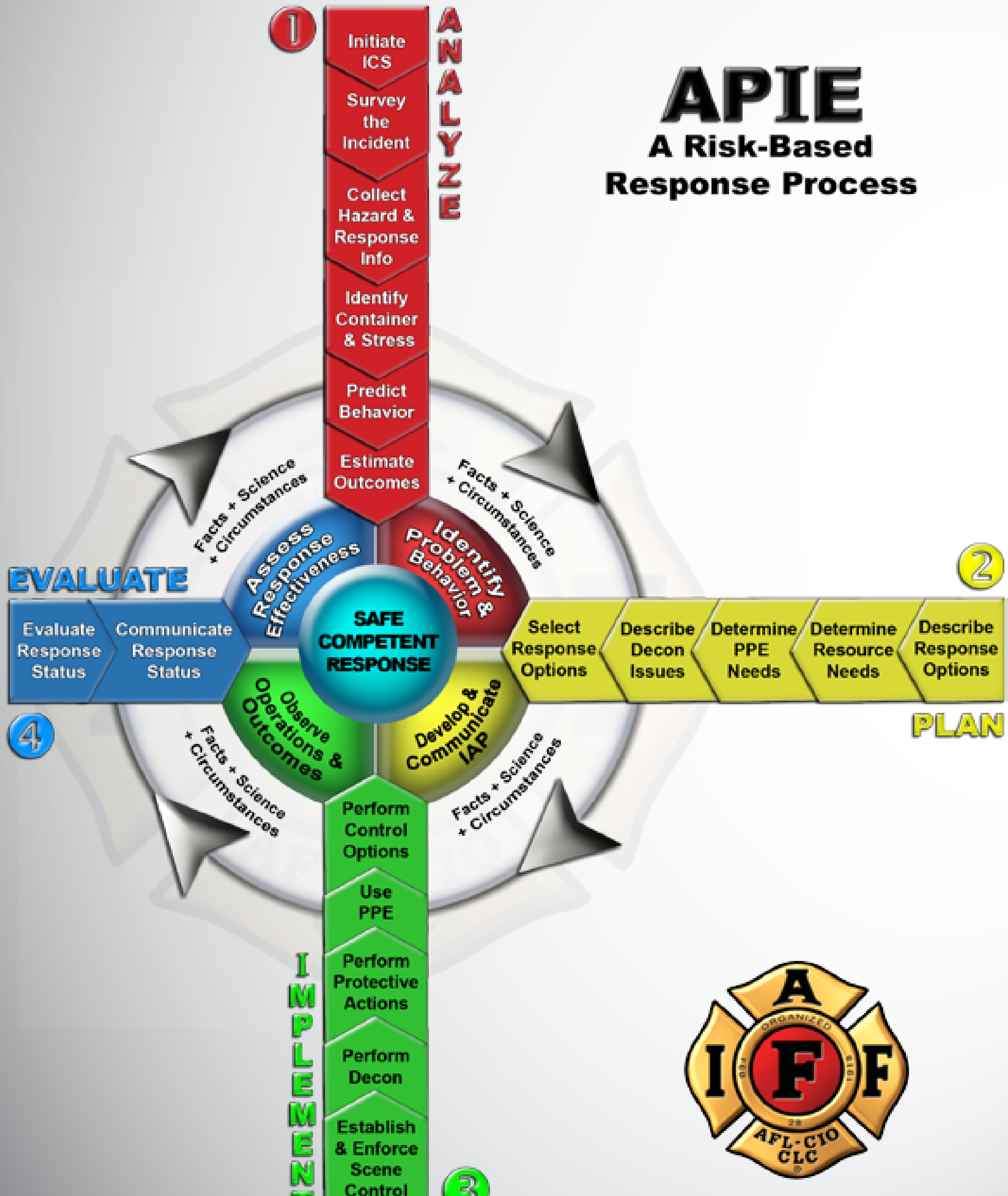
Module 2:

Risk-Based Response Actions



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Module 2 – Risk-Based Response Actions

Module 2 Objectives

After completing this module, you will be able to identify the risk-based response actions related to each of the steps in the APIE process:

- Analyze the problem
- Plan the response
- Implement the plan
- Evaluate the progress

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Isotec Case Study, Miami Township, OH[1]

On Sunday, September 21, 2003, at about 7:30 a.m., the Isotec on-call system operator received an automatic pager alert indicating an alarm condition in a cryogenic nitric oxide (NO) distillation unit. Arriving at the facility at about 7:50 a.m., he observed reddish-brown gas venting from the distillation unit vacuum pump exhaust — which indicated a breach in the column piping within the vacuum jacket. Nitric oxide – a toxic gas — was venting to the atmosphere and reacting with air to form nitrogen dioxide (NO_2), also a toxic gas. The responding employee immediately notified his supervisor, who called the 911 dispatcher. Isotec management and Sigma-Aldrich, the parent company of Isotec, were then notified.

The reddish-brown gas cloud was observed drifting southwest from the site and slowly dissipating. By 8:15 a.m., employees secured the leak by closing the vacuum pump suction valve. Shortly thereafter, the vapor cloud was no longer visible. The operations manager and five other Isotec employees believed they could safely remove the nitric oxide from the N3 distillation column and vacuum jacket, and proceeded with the necessary preparations.

Their position was based on successful application of the same strategy to a column malfunction on September 18, 1998. Distillation column N4 (same design as N3) had developed a nitric oxide leak into the vacuum jacket and vented nitric oxide from the vacuum exhaust. While closely monitoring pressure and temperature, operators successfully emptied the nitric oxide from the column and vacuum jacket.

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[1] Investigation Report: Confined Vapor Cloud Explosion. United States Chemical Safety and Hazard Investigation Board (CSB) Case Study. Report No. 2007-03-I-MA. May 2008. <http://www.chemsafety.gov/>

Once the leak was secured, personnel began installing temporary tubing to empty the nitric oxide in the malfunctioning column. Concurrently, they closely monitored the pressure inside the column, which was behaving as in 1998 when column N4 leaked nitric oxide. The pressure stabilized at no more than 130 pounds per square inch (psi) – well below the vacuum jacket calculated burst pressure of 1,645 psi. Isotec personnel noted that the condenser was “vigorously venting nitrogen vapor,” which indicated increased heat load in the column.

At 10:15 a.m. – with no warning – a violent explosion destroyed the distillation column, the blast containment structure and nearby buildings (Figure #1, see page 73). Windows were blown out of the main office building about 140 feet from the explosion; and glass shards lacerated the hand of an Isotec employee. No other injuries were reported. Small chunks of concrete and metal shards were propelled as far as 1,000 feet and fell on adjacent property. Three houses north of the facility were struck by debris, causing minor damage to two roofs and a picture window. A large steel panel from the blast containment structure struck and dislodged a 52,000-pound gaseous carbon monoxide (CO) storage vessel, pushing it about 10 feet off its foundation (Figure #2, see page 73). A second steel panel severely damaged adjacent equipment (Figure #3, see page 75). A ruptured fill line vented CO gas, which then ignited and burned for about an hour, until the vessel was empty (Figure #4, see page 75).

As a precaution, the fire department requested that police evacuate a one-mile radius to protect the community from metal shards or other debris in the event that the CO vessel exploded. The evacuation order was lifted after 24 hours.

Figure #1: 20-foot diameter, 8-foot deep crater and structural damage caused by NO unit process explosion

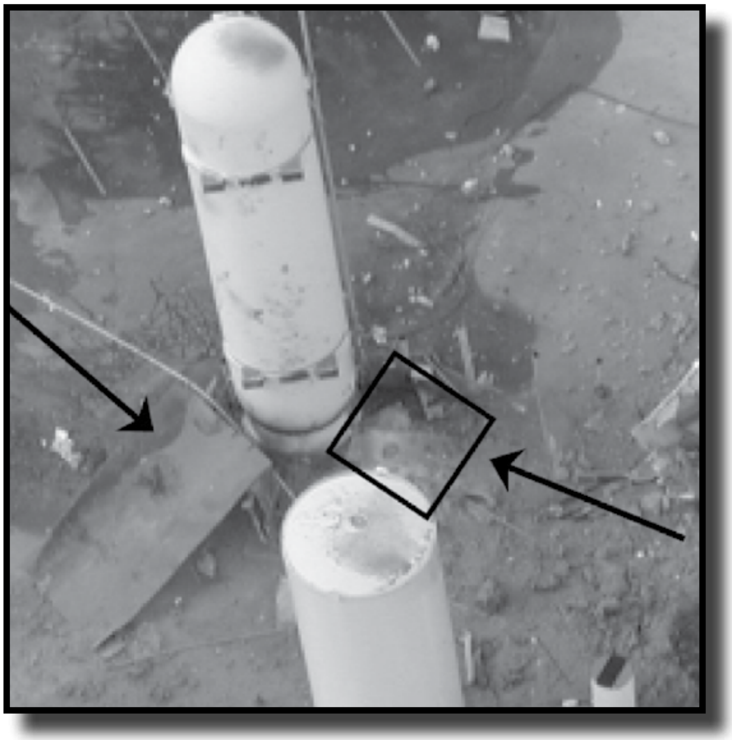

Figure #2: 52,000-pound, 42-foot tall CO vessel pushed 10 feet off foundation (right arrow) by blast panel (left arrow)

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Figure #3: Blast containment structure damaged by steel blast panel

Figure #4: CO gas venting from ruptured fill line (arrow) on the displaced vessel

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Risk-Based Response Actions for Isotec, MO Case Study

Team Activity

Refer to the APIE Model and Checklist as you discuss the case study with your team.

Analyze the Problem

Use the space below to write parts of the case study which illustrate or fit into the Analyze the Problem step of APIE: A Risk-Based Response Process.

Plan the Response

Use the space below to write parts of the case study which illustrate or fit into the Plan the Response step of APIE: A Risk-Based Response Process.

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Implement the Plan

Use the space below to write parts of the case study which illustrate or fit into the Implement the Plan step of APIE: A Risk-Based Response Process.

Evaluate the Progress

Use the space below to write parts of the case study which illustrate or fit into the Evaluate the Progress step of APIE: A Risk-Based Response Process.

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Actions to Analyze the Problem

As you learned earlier, the APIE process can be applied to all types of emergencies (chemical process industry and others) including those at commercial fixed sites, along transportation corridors, at non-structural locations, and at residences. Each step of the process requires a set of standardized actions from emergency response personnel, beginning with analyzing the problem.

Analyzing the problem begins with consideration of dispatch while en route and upon arrival on scene:

- Initiate Incident Command System (ICS)
    - Establish command
    - Set up Incident Command Post (ICP)
    - Communicate command and ICP locations
- Survey the incident (scene)
- Collect and interpret information
    - Hazards, including hazmats present
    - Container types and stress
    - Weather conditions should be monitored throughout the duration of an incident
        - Weather conditions may change significantly over the course of a long incident.
        - Temperature extremes, lightning, humidity, precipitation, wind and atmospheric inversions can negatively affect the outcome of an incident.
- Predict the behavior of hazmats and containers
- Estimate outcomes
- Conduct a risk-benefit analysis

Additional information on how weather affects responders is provided in the Appendices on page A-32.

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The three major factors to consider when analyzing the problem are:

- Hazards present
- Exposures — life, property and environment
- Risk

Any information obtained during pre-incident planning should be considered along with dispatch, size-up and research information. For each exposure, assess its susceptability to harm. Use this information to predict behavior and estimate outcome — i.e., determine the probablilty and types of damage/injury which may occur. Consider worse-case scenarios.

Consider Dispatch Information

Emergency response personnel are encouraged to ask for additional information to supplement the facts that were in the initial dispatch. If the involvement of a specific chemical can be ascertained, it can be researched while on the way to the scene to optimize response efficiency and effectiveness, and to take appropriate safety precautions.

Initiate Incident Command System

Typically, command is established by the company officer of the first arriving unit. The IC must be identifiable and located at the ICP as soon as practical. First responders must secure the scene, control access to the area and initiate the ICS as early as possible during the incident. Numerous government agencies and private firms may become involved in chemical process industry incidents and it is essential that all work seamlessly together within the structure of the ICS. A diagram of the ICS organizational structure is provided in the Appendices on page A-31.

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Survey the Incident (Scene)

Surveying, or size-up, begins before the response, and continues beyond termination of the incident. Strategic priorities are the same: life safety (emergency responders and civilians), incident stabilization and property conservation.

For most incidents, a 360º view or walk-around of the scene allows responders to consider the whole scene. However, chemical process industry sites are usually too large to perform a walk-around. Responders should attempt to scan as much of the facility as possible.

During size-up, keep in mind the principles of time, distance and shielding. Position yourself uphill and upwind of any release and consider terrain and weather conditions. Determine the identities, quantities, handling considerations and locations of the involved hazardous materials; by what means the material is spreading; and the hazards likely to result from the release.

Collect and Interpret Information

Determine what, if any, containers and processes are in use. If possible, magnify the image by using binoculars so that you are able to maximize the distance between yourself and the incident area. Responders must evaluate container markings and estimate the amount of hazardous chemicals/materials present, as well as the form of the chemical/material and the point of release.

The use of multiple reference materials (responders should attempt to use at least three sources) in the evaluation of the material(s) involved, the chemical and physical properties, as well as other hazards that could be present, are all important in determining the strategy and tactics in the development of the IAP.

Conditions surrounding the incident must also be considered; responders should monitor the scene continuously for possible ignition sources. Accessibility must be evaluated and weather conditions, including general wind direction and forecasted conditions, should be noted.

In addition, many forms of information will be handed to you at a facility that you may not be familiar with, and thus may not immediately understand. During an incident is no time to see these forms for the first time. EPA Tier II reporting forms are a perfect example. Many of these forms have codes that are not on the form itself. You have to be able to know from whom or where to get that information. By obtaining these forms you will be able to examine the location of your incident and any associated hazards. Examples of Tier II reporting codes and forms were discussed in Module 1 and are provided in the Appendices on pages A-26 to A-30.

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Risk-Benefit Analysis

The nature of emergency response carries some amount of risk no matter how well-trained, equipped or prepared you are. However, risk caused by lack of training, lack of proper equipment or lack of preparation is unacceptable. You have a responsibility to yourself and your family to ensure that your department remains proactive and current in these areas.

There are other, less controllable, factors that play a role in the level of risk during emergency response. These are the on-scene emergency issues that vary from one emergency situation to another.

While it may seem impossible to plan your actions for these types of issues, there are some basic principles that can guide your decisions. They are based on balancing the risk to your health and safety with the likely benefits of your actions. First responder actions should be based on the likely benefits of those actions weighed against the level of risk likely in the situation.

The appropriate choice between offensive and defensive operations is rarely clear, especially when victims are involved. The following method will help you determine the probability of a victim's survival:

- Confirm victim's physical status.
    - Is the victim calling for help?
    - Is the victim visibly moving or unconscious?
    - How long has the victim been trapped or exposed to hazmat(s)?
- Determine the hazmats present, their chemical/physical properties and the severity of conditions.
    - Is the material visible — pool or vapor?
    - How much is present?
    - Are there ignition sources? Is a large fire or explosion likely?
- Ensure responders have the necessary training and PPE and clothing to perform a rescue.

In addition to determining your goal — rescuing victims versus protecting property — your experience, your level of training, the PPE available to you, and information available about the hazards involved will help you determine your likelihood of success. Preserving emergency responder safety and health should be the basis for determining emergency responder actions. However, it is equally important to remember that first responders often have the tools and knowledge needed to make successful rescues.

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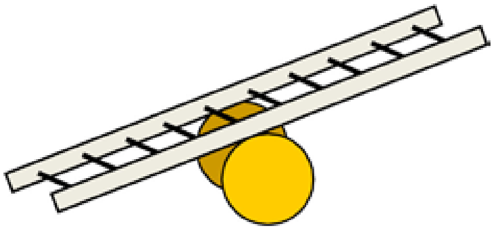
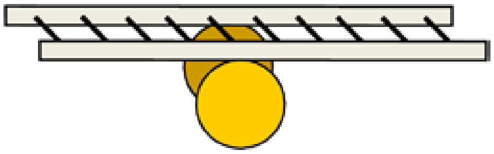
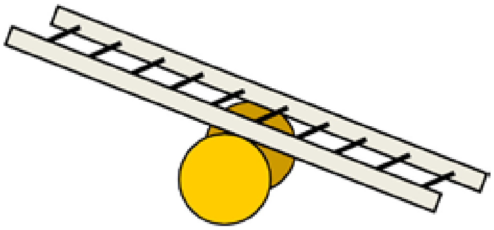
Many first responders learn from early training that offensive strategy and tactics are necessary for success. However, offensive strategies can expose response personnel to the extreme and unusual hazards that chemical process industry incidents can present. In suspected chemical process industry incidents, offensive strategies and tactics are not wise without clear information about the hazards.

Assume No Risk  **Rescue Property Only** **Risk Outweighs Benefit**	When actions are directed toward property conservation only, first responders should be subjected only to **low-risk environments**.
Moderate Risk for Fire Fighters **Victims, Low Probability of Survival** 	When actions are directed toward the rescue of trapped victims with a low probability of survival, first responders may be subjected to **moderate-risk environments**.
Victims, High Probability of Survival  **Assume High Risk for Probable High Gain** **Benefit Outweighs Risk**	When actions are directed toward the rescue of victims with high probability of survival, first responders may be subjected to **high-risk environments**. It is reasonable to face risks in order to save a life when the potential benefits outweigh probable risks.

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Use the space below to write your responses and notes related to risk-benefit analysis.

1. **What are some examples that fit the risk-benefit scenarios below?**
   a. Risk outweighs the benefit.

   ____

   ____

   b. Risk and benefit are somewhat equal.

   ____

   ____

   c. Benefit outweighs the risk.

   ____

   ____

2. **What are the challenges involved in making the right calls during an incident in terms of risk versus benefit?**

   ____

   ____

   ____

   ____

   ____

   ____

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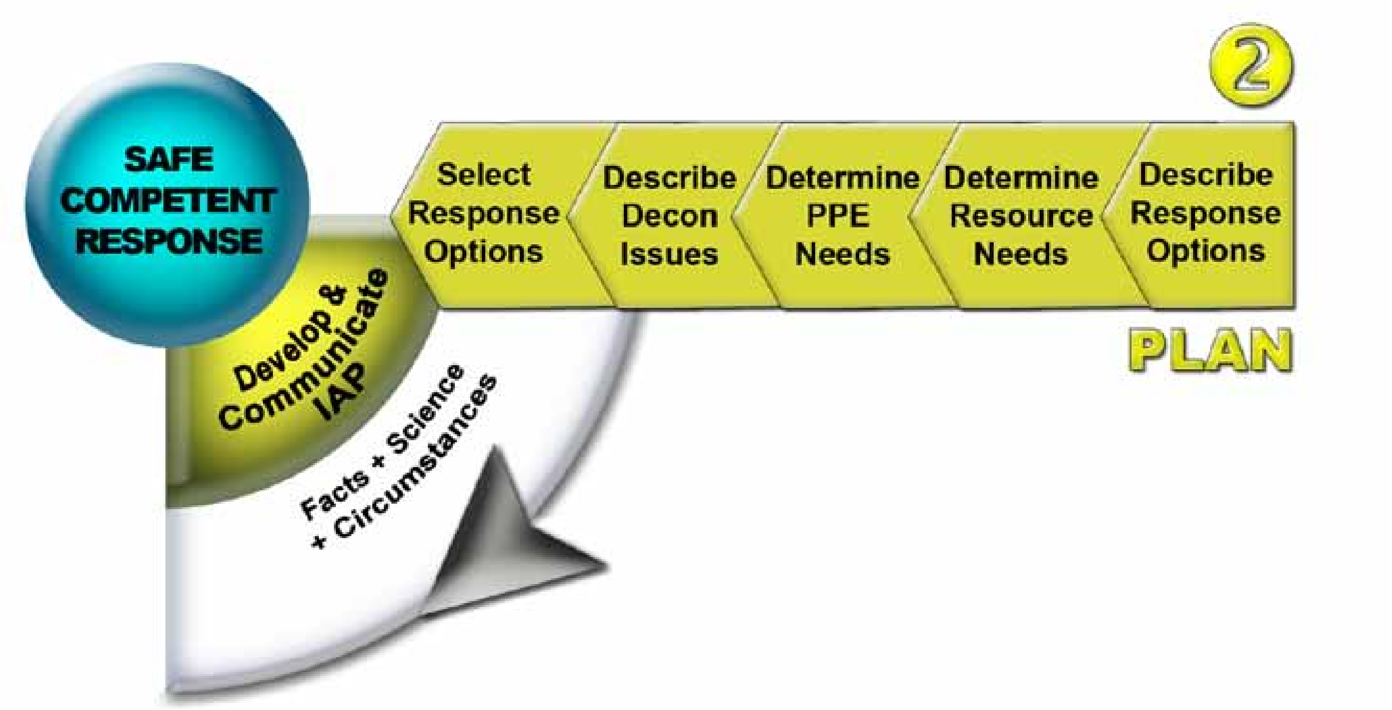
Actions to Plan the Response

As discussed in the previous module, pre-incident planning is important in identifying the presence of chemical process industry facilities and the impact they may have on a community and its resources in the event of an incident. The information in a pre-incident plan will assist the first responders in making effective decisions and developing an IAP during emergencies.

Analyzing the problem is critical for planning the response. Once the problem and likely behaviors have been identified, use the information to:

- Describe response objectives and the options or actions that could be taken to achieve each objective
- Determine the resource needs for each option, including personnel (how many and with what level of training) and equipment
- Determine the suitability of PPE
- Identify and describe decontamination issues — how contamination might occur, potential for secondary contamination, limitations of procedures, and factors specific to the hazmats
- Select response options or actions to be taken

Additional information on PPE is provided in the Appendices on page A-34.



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It is essential for the Incident Commander to have an IAP. For small incidents that are easily controlled, the IAP may be mental and communicated orally by the IC, while larger scale incidents involving multiple agencies over several operational periods may require a written IAP.

An effective plan includes current information that describes the incident situation as accurately as possible, as well as the resources available, predictions of the probable course of events, and alternative strategies to attain the desired objectives. This is especially true for incidents at chemical process industry facilities due to the potential hazards of the materials, the processes present, and their complexities and size.

Response Options for Chemical Process Industry Incidents

Fire fighters have an array of offensive and defensive measures at their disposal for fire fighting operations. When hazardous materials or chemicals are involved, as is often the case at chemical process industry incidents, emergency response personnel at the operations level of training need to limit their actions to isolating the dangerous material with defensive tactics. More than one of the possible strategies may be used in the course of a chemical process industry incident. For each response option, the necessary resources—to safely implement the option—must be determined.

Operations-level responders may perform one or more of the following defensive response options as specified in their jurisdictions SOPs/SOGs:

- Extinguishment
- Vapor suppression
- Vapor dispersion
- Absorption
- Dilution
- Neutralization
- Remote valve shut-off
- Constructing dikes, damming, diverting and retention

Additional information on dikes, dams, diversion and retention areas is provided in the Appendices on page A-33.

After selecting response options, use the information considered to develop an IAP. The IAP should then be communicated to all responders.

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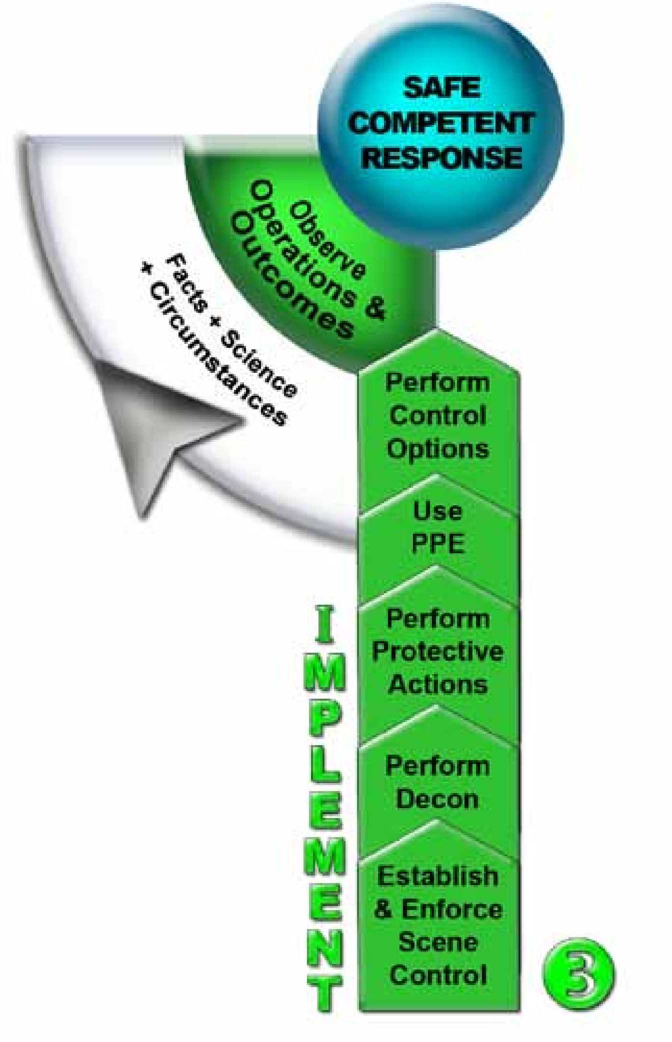
Actions to Implement the Plan



Once the plan has been developed and communicated, actions can be taken to implement the plan, including:

- Establish and enforce scene control procedures.
    - Establish zones (hot/warm/cold)
    - Staging, decontamination and EMS
- Establish a means of evidence preservation, if necessary.
    - Where criminal or terrorist acts are suspected
    - In accordance with local SOPs/ SOGs
- Establish an emergency decontamination area (prior to personnel entering hazardous area).
- Perform protective actions.
    - Rescue/recovery
    - Evacuation
    - Shelter-in-place
- Don PPE.
- Perform control options.
- Remove PPE properly and take appropriate measures to prevent secondary contamination.
- Perform emergency decontamination.

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Establish and Enforce Scene Control Procedures

Use the space below to take notes on establishing zones.

Control zones are areas at hazmat/WMD incidents within an established area or controlled perimeter. Hot, warm and cold zones are designated based on safety and level of hazard. The goal is to isolate the hazard at its origin and keep the public away from it in order to assure control of the site, avoid spreading contaminants, and enable the safe movement and tracking of personnel and equipment on scene.

It is also important that you establish an incident entry point and communicate it to all of the responding units. A personnel accountability system should also be established as responding units arrive on the scene.

Hot Zone

The hot zone, also known as the exclusion zone, is the area immediately surrounding the incident which extends far enough to prevent adverse effects of hazards to personnel outside the zone. It is restricted to essential personnel using appropriate protective clothing and equipment — ideally, a hazmat unit. Access to this area is tightly controlled at a single entry point, and limited to assigned entry teams who are specially trained to control the incident through offensive measures.

Time within the hot zone must be minimized through careful planning and monitoring. The entry team must have communication devices and alternate plans for communication and emergency evacuation signals in place, in case it becomes necessary for entry teams to evacuate.

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Warm Zone

The warm zone, also known as the decontamination or contamination reduction corridor, is the control zone at hazmat/WMD incidents, including those at chemical process industry sites. This is where personnel and equipment are decontaminated, and hot zone or entry support takes place.

Decontamination in the warm zone requires personnel to use PPE appropriate to the level of hazard present. The decontamination personnel should be in a level of protection that is not more than one level below the entry team. If the entry team is in Level A protection, the personnel need to be in at least Level B. In some instances, the first station in the decontamination process (gross decon) may require the same level as the entrants.

For incidents involving hazmats, chemical protective clothing is needed to operate in the decontamination corridor, as well as appropriate training and supervision.

The line that separates the hot zone from the warm zone is the hot line, which may be marked with barrier tape, safety cones or other highly visible devices.

The contamination reduction corridor can be set up in the uncontaminated area and the hot line moved to the edge of the zone. This area can be a safe area until the first entry person is directed into the first step of the decontamination process. The entire area is then considered the warm area and all personnel in this area must be utilizing the appropriate level of PPE as identified in the IAP.

Cold Zone

The cold zone is the control area where the ICP and other support functions needed to control the incident are located (e.g., rehabilitation for response personnel, treatment for decontaminated patients). The public is also excluded from this area to allow the fire department and other emergency response agencies space to work.

The cold zone should be secure from uninvited parties, and entry into the cold zone should be controlled to prevent injury and illness. The outer edge of the cold zone should be the crowd control perimeter.

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Emergency Decontamination[1]

First responders at the operations level are limited to emergency decontamination with hoselines unless specially trained and supervised. Emergency decontamination, although not as effective as technical decontamination, limits cross-contamination in life-threatening situations.

Many types of chemicals can be absorbed into individuals' clothing, skin and hair if they were in close proximity to the source. Emergency decontamination protects responders and others from hazardous materials that may have contaminated victims who were in the area of a hazardous materials release.

Decontamination is a major challenge at a scene involving the release of any type of chemical. The type, quantity, persistency and the method of dispersal of the agent; the location of the release (i.e., inside or outside a structure); number of people involved; and weather conditions are factors that influence the decontamination process.

Decontamination procedures should be performed as soon as possible, but should not compromise the health and safety of the persons being decontaminated.

Decontamination procedures must be specific for the type of hazard involved (e.g., do not use water on water-reactive materials). If appropriate, copious amounts of water should be used to flush all exposed contaminated body parts. When possible, responders should try to have victims remove (and double bag) their own clothing and wash themselves down with water to avoid secondary contamination. Following flushing, victims should be transferred to a clean area for first aid and medical treatment.

Prior to transporting the patient, the receiving health care facility should be advised of the condition of the patient and the contaminant involved (if known) so they can take appropriate actions to prevent secondary contamination of their facility.

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[1] Investigation Report: Confined Vapor Cloud Explosion. United States Chemical Safety and Hazard Investigation Board (CSB) Case Study. Report N0. 2007-03-I-MA. May 2008. <http://www.chemsafety.gov/>

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It is also important to protect the ambulance or other vehicle used to transport the patient before placing them into the patient treatment area. Only the items necessary to ensure proper care for the present patient should be in the transport/treatment area of the vehicle. This will minimize the amount of equipment that could possibly be affected by secondary contamination. Also, those in the vehicle should utilize the level of PPE to protect themselves from contamination and ensure there is sufficient ventilation of the compartment.

Use the space below for your notes on decontamination.

What factors should be considered when performing emergency decontamination?

Additional information on decontamination is provided in the Appendices on pages A-35 to A-36.

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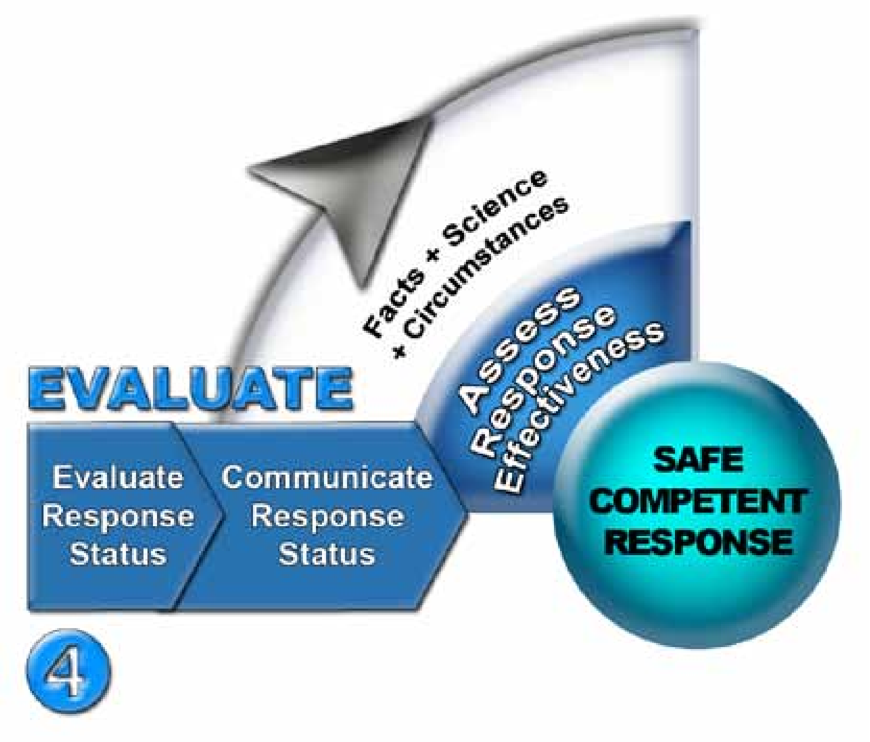
Actions to Evaluate the Progress

As is the case with any type of response, a chemical process industry response will evolve over time, and this evolution may not follow the same pattern each time. At an incident, evaluation must take place continually, and responders may need to adjust their strategies based on changing circumstances. For example, they may need to take a defensive, or non-intervention strategy, as opposed to an offensive strategy.

Evaluation may reveal the need for revision. This may mean a small or large adjustment in the IAP. If an adjustment is made, ensure all parties are informed of the intended change(s).



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Use the space below for your responses related to the Evaluate the Progress step of the APIE process.

1. **What questions should be considered in order to determine to what extent the response objectives are being met?**

2. **How do you know whether actions at a response are effective?**

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Changing Circumstances

Plans and strategies can change drastically — and frequently — depending on how a given incident evolves. All involved units and support personnel should be kept informed of the response status, on an ongoing basis, until the incident is formally terminated. Keeping lines of communication open and disseminating accurate information are difficult tasks to accomplish during the process of stabilizing an emergency, but are needed for coordinated, safe and efficient incident resolutions.

Some examples of situations which may require that the IAP should be adjusted include:

- The need to preserve evidence
- Risks associated with response change
- Number of victims requiring rescue changes

Use the space below for your responses related to changing circumstances.

What are some additional examples of situations that could occur which would dictate that an IAP should be adjusted?

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Incident Termination

Termination of hazardous materials incidents, including those at chemical process industry sites, must include transfer or termination of command, record keeping, debriefing, post-incident analyses and critique.

The debriefing is conducted as soon as the incident is over. Debriefing should not be a long process—no longer than 10 to 15 minutes. During debriefing, discussion should include the material(s) which were involved in the incident, signs and symptoms of exposure (and the importance of seeking medical attention if these are noted) and any equipment damaged or broken during response actions. The IC should thank the responders for their actions at the end of the debriefing.

Problems during the response can be addressed during the critique. The critique should be facilitated by a person who was not involved in the actual incident, but has knowledge of incident response. This helps to ensure an objective critique. The facilitator should start the critique with the positive items, then address areas for improvement and finish with the positive items. Resources can include maps, radio transmission recordings and any other additional aids. During the critique, it may be determined that SOPs/SOGs need to be developed or revised, or more training needs to be provided.

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Module 3:

Case Studies

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Module 3 – Case Studies

Module 3 Objectives

After completing this module, you will be able to work through each step of APIE: A Risk-Based Response Process at a chemical process industry incident using:

- Hazmat references (e.g., ERG, NIOSH Pocket Guide and MSDSs)
- APIE Worksheet which includes a Chemical/Physical Properties Identification Form

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Video

Use the space below for your notes on the case study videos.

1. **Des Moines, IA**

2. **Augusta, GA**

3. **Festus, MO**

4. **Dalton, GA**

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Team Preparation

Follow the instructions below for your team's case study assignment.

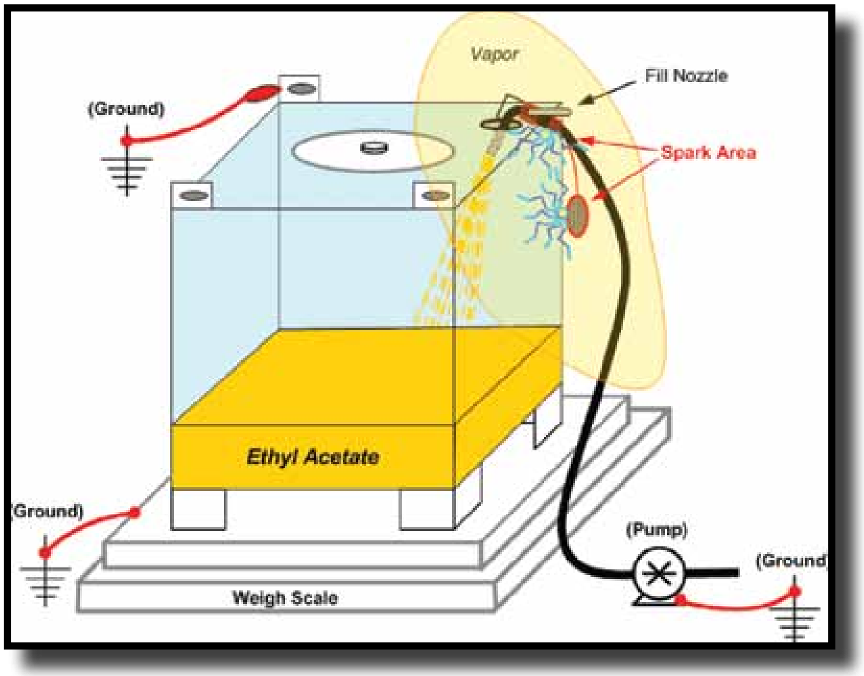
- *Read the case study individually.*
- *Work through the APIE process with your team and complete the APIE worksheet based on your team's what if scenario.*
- *For references, use the 2008 ERG and NIOSH Pocket Guide and the MSDSs and Chemical Safety Cards provided in the Appendices beginning on page A-37.*
- *Team assignments are as follows.*
    - *Team 1*
        - *Des Moines, IA*
        - *Pages 122 - 129*
        - *What if you were called when the initial fire started in Des Moines, IA?*
    - *Team 2*
        - *Augusta, GA*
        - *Page 130 - 137*
        - *What if you were called because workers were overcome after entering the vessel in Augusta, GA?*
    - *Team 3*
        - *Festus, MO*
        - *Pages 138 - 149*
        - *What if you were called for a slow, rather than high-volume, release at Festus, MO?*
    - *Team 4*
        - *Dalton, GA*
        - *Pages 150 - 161*
        - *What if you were called for a run-away reaction during the production of one of the smaller, trial batches at Dalton, GA?*

Des Moines, IA — Barton Solvents Case Study– Team 1[1]

On October 29, 2007, at about 1:00 p.m., a fire and series of explosions occurred at the Barton Solvents chemical distribution facility in Des Moines, Iowa, causing the evacuation of thousands of residents and sending projectiles into the surrounding community. Barton Solvents packages, stores and delivers solvents and other chemical products, many of which are widely used in the paint and coatings industry.

The initial fire started in the packaging area while a 300-gallon portable steel tank, known as a tote, was being filled with ethyl acetate, a flammable solvent. An operator placed the fill nozzle in the fill opening on top of the tote and suspended a steel weight on the nozzle to keep it in place. After opening the valve to begin the filling process, the operator walked across the room to do other work. As the tote was filling, he heard a popping sound and turned to see the tote engulfed in flames and the fill nozzle lying on the floor discharging ethyl acetate.

A fireball erupted from the tote. Pressure from the eruption knocked the filling nozzle out of the tank, spraying ethyl acetate into the room and onto the operator. His clothing ignited, but he quickly removed the ignited clothing and escaped serious injury. Another operator tried to use a hand held extinguisher to battle the blaze, but it emptied before the fire could be extinguished. He then shut off all power to the area and the plant was successfully evacuated.



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[1] Static Spark Ignites Flammable Liquid during Portable Tank Filling Operation. United States Chemical Safety and Hazard Investigation Board (CSB) Case Study. Report No. 2008-02-I-IA. September 2008. <http://www.chemsafety.gov/>

A local exhaust ventilation system to remove vapors generated during filling operations was available, but was not turned on at the time of the incident. This system was severely damaged during the incident. As no design plans nor specifications were available for review, the CSB was unable to determine if its use could have prevented the initial fire by reducing the concentration of the flammable vapors below the ignitable range.

The packaging area was adjoined to the flammable storage warehouse. A wall separating the two areas was not fire-rated, and large non-fire-rated doors between the warehouse and packaging area were kept open and were not equipped with self-closing mechanisms. The CSB believes that this lack of effective separation aided the fire to spread rapidly into the warehouse area.

The warehouse had an automatic sprinkler system, which did not extend into the packaging area where flammable liquids were routinely stored. Barton's property insurance company had recently recommended that Barton install an automatic fire suppression system in the packaging area.

The fire started in the packaging area and quickly spread to the warehouse. The warehouse sprinkler system activated after the fire had gained momentum in the packaging area, but was incapable of extinguishing the blaze. At the time of the fire, several 55-gallon drums and approximately 30 smaller containers (i.e., 1-5 gallons) of flammable liquids were stored in the packaging area.

If a fire suppression system had been installed in the packaging area, and that area had been separated from the warehouse by fire-rated walls and doors, this fire likely would have been extinguished or contained before engulfing the entire warehouse.

One employee received minor injuries and one fire fighter was treated for a heat-related illness. A large plume of smoke and rocketing barrels and debris triggered an evacuation of the businesses surrounding the facility. The main warehouse structure was destroyed and Barton's business was significantly interrupted, but the fire was contained in the initial incident footprint.

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APIE Worksheet

Use this worksheet to work through the following what-if scenario for the Des Moines, IA case study.

What if you were called when the initial fire started?

Analyze the Problem GOAL = Identify the Problem and Likely Behavior

Use the Chemical/Physical Properties Identification Form (next page) to help you collect the hazard information you'll need to predict behavior of hazmats and containers and estimate outcomes. Use the space below for your notes.

Type of Incident

☐ Fire/explosion ☐ Release ☐ Confined space ☐ Reactive chemicals

Initiate ICS ______________________________

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Survey the Incident ______________________________

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Collect Hazard and Response Information ______________________________

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Identify Container Type(s) and Stress ______________________________

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Predict Behavior ______________________________

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Estimate Outcomes ______________________________

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Chemical/Physical Properties Identification Form

Product/Chemical Names:	References Used:

Chemical and Physical Properties

Physical State:	Form:	Vapor Pressure: mmHg/ATM
Flammable: Yes/No	LEL: %	UEL: %

Flash Point (Fl.P): ºF/C	Boiling Point (BP): ºF/C
Ignition (Auto) Temperature: ºF/C	

Molecular Weight (MW):	Vapor Density (VD):
Lighter/Heavier than Air:	Volatility:
Specific Gravity (Sp.Gr.);	Solubility (SOL):
Corrosive: pH	Reactive (with):
Polymerization (potential): Yes/No	

Radioactive: Yes/No	Alpha:	Beta:	Gamma:

Health

Toxic: Yes/No	Routes of Exposure: Inhalation/Absorption/Ingestion/Injection

Exposure Limits:	TLV-TWA:	TLV-STEL:
TLV-C:	PEL	IDLH:
Comments:		

Plan the Response

GOAL = Develop and Communicate the IAP

Use the space below for your notes.

Describe Response Objectives ______________________________

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Determine Personnel/Equipment Needs ______________________________

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Determine PPE Needs ______________________________

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Describe Decon Issues ______________________________

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Select Response Objectives ______________________________

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Implement the Plan

GOAL = Observe Operations and Outcomes

Use the space below for your notes.

Establish and Enforce Scene Control ______________________________

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Perform Decon ______________________________

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Perform Protective Actions ______________________________

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Use PPE ______________________________

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Perform Control Options ______________________________

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Evaluate the Progress

GOAL = Assess Response Effectiveness

Use the space below for your notes.

Evaluate Response Status ______________________________

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Communicate Response Status ______________________________

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Augusta, GA — BP Amoco Polymers Case Study – Team 2[1]

On March 13, 2001, three people were killed as they opened a process vessel containing hot plastic at the BP Amoco Polymers (now Solvay Advanced Polymers, L.L.C.) plant in Augusta, Georgia. They were unaware that the vessel was pressurized.

The workers were killed when the partially unbolted cover blew off the vessel, expelling hot plastic. The force of the release caused some nearby tubing to break. Hot fluid from the tubing ignited, resulting in a fire.

The BP Amoco Polymers Augusta facility produced plastics, including Amodel, a hard but moldable high-performance nylon. Amodel is manufactured by passing a solution of di-amines and di-carboxylic acids through a series of reactors. The reaction is completed in an extruder, and the material is then formed and cooled into solid pellets.

Workers were attempting to open a cover on a process vessel when the incident occurred. The vessel–referred to as the polymer catch tank (KD-502)–was designed to receive partially reacted waste Amodel diverted from a chemical reactor during periods of startup and shutdown.

Twelve hours prior to the incident, an attempt was made to start the production unit. After approximately 1 hour, the startup was aborted due to problems with the extruder downstream of the reactor–but not before an unusually large amount of partially reacted material had been sent to the polymer catch tank.

Hot molten plastic inside the polymer catch tank continued to react and also began to slowly decompose, thereby generating gases (pressurization) and causing the contents to foam. The material expanded as foaming continued, and eventually the entire tank was filled. The material then forced its way into connecting pipes, including the normal and emergency vents.

Once in the pipes, the plastic solidified as it cooled. A hardened layer of plastic 3 to 5 inches thick also formed around the entire inner wall of the tank. However, the core of the plastic mass remained hot and molten, and likely continued to decompose over several hours, generating gases that pressurized the vessel.

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[1] Investigation Report: Thermal Decomposition Incident. United States Chemical Safety and Hazard Investigation Board (CSB) Case Study. Report No. 2001-03-I-GA. JUNE 2002 <http://www.chemsafety.gov/>

Before opening the polymer catch tank, personnel may have relied on a pressure gauge and a transmitter on the vent piping from the vessel to ascertain whether it was under pressure. They also knew that the process was shut down. However, any reading from the pressure gauge would likely have been unreliable because plastic had entered the vent line and solidified.

On previous occasions, the polymer catch tank contained no pressure when it was opened. Varying amounts of plastic were found inside; sometimes the plastic was hot, but it was always solid. Expecting that to be the case again, the workers proceeded to remove the 44 bolts from the cover. When half of the bolts had been removed, the 1,750-pound cover suddenly blew off the polymer catch tank. A mass of hot plastic was ejected from the 48-inch-diameter tank opening, traveling as far as 70 feet. The cover and the expelled plastic struck the workers, killing them.

Witnesses described the subsequent formation of a plume of white smoke or steam in the Amodel unit, but no visible fire after the first explosion. The maintenance technician and both operators suffered severe impact trauma.

The force created by the ejection of gas and plastic propelled the polymer catch tank backward and bent the attached piping. A section of hot oil supply tubing (370°C) for a heating jacket on the inlet line from the reactor knockout pot to the catch tank broke; the hot oil escaped and formed a vapor cloud, which ignited at 2:42 a.m.

Following the initial explosion, the plant emergency response team, the plant fire brigade, and the Richmond County Fire Department responded to the incident.

The area water deluge system was activated manually and manual hose streams were used to control the fire. The victims were recovered, and cardiopulmonary resuscitation (CPR) was administered to one of them. After emergency responders isolated the hot oil system, the fire was extinguished at about 8:15 a.m. on March 13.

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APIE Worksheet

Use this worksheet to work through the following what-if scenario for the Augusta, GA case study.

What if you were called because workers were overcome after entering the vessel?

Analyze the Problem GOAL = Identify the Problem and Likely Behavior

Use the Chemical/Physical Properties Identification Form (next page) to help you collect the hazard information you'll need to predict behavior of hazmats and containers and estimate outcomes. Use the space below for your notes.

Type of Incident

☐ Fire/explosion ☐ Release ☐ Confined space ☐ Reactive chemicals

Initiate ICS ______________________________

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Survey the Incident ______________________________

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Collect Hazard and Response Information ______________________________

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Identify Container Type(s) and Stress ______________________________

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Predict Behavior ______________________________

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Estimate Outcomes ______________________________

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Chemical/Physical Properties Identification Form

Product/Chemical Names:	References Used:

Chemical and Physical Properties

Physical State:	Form:	Vapor Pressure: mmHg/ATM
Flammable: Yes/No	LEL: %	UEL: %

Flash Point (Fl.P): ºF/C	Boiling Point (BP): ºF/C
Ignition (Auto) Temperature: ºF/C	

Molecular Weight (MW):		Vapor Density (VD):	
Lighter/Heavier than Air:		Volatility:	
Specific Gravity (Sp.Gr.);		Solubility (SOL):	
Corrosive: pH		Reactive (with):	
Polymerization (potential): Yes/No			
Radioactive: Yes/No	Alpha:	Beta:	Gamma:

Health

Toxic: Yes/No	Routes of Exposure: Inhalation/Absorption/Ingestion/Injection

Exposure Limits:	TLV-TWA:	TLV-STEL:
TLV-C:	PEL	IDLH:
Comments:		

Plan the Response

GOAL = Develop and Communicate the IAP

Use the space below for your notes.

Describe Response Objectives ______________________________

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Determine Personnel/Equipment Needs ______________________________

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Determine PPE Needs ______________________________

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Describe Decon Issues ______________________________

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Select Response Objectives ______________________________

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Implement the Plan

GOAL = Observe Operations and Outcomes

Use the space below for your notes.

Establish and Enforce Scene Control ____________________________

Perform Decon ____________________________

Perform Protective Actions ____________________________

Use PPE ____________________________

Perform Control Options ____________________________

Evaluate the Progress

GOAL = Assess Response Effectiveness

Use the space below for your notes.

Evaluate Response Status ______________________________

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Communicate Response Status ______________________________

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Festus, MO — DPC Enterprises, L.P. Case Study – Team 3[1,2]

On the morning of August 14, 2002, 48,000 pounds of chlorine were released over a three-hour period during a railroad tank car unloading operation at DPC Enterprises, L.P., near Festus, Missouri. The facility repackages bulk liquid chlorine into 1-ton containers and 150-pound cylinders for commercial, industrial and municipal use in the St. Louis metropolitan area.

Chlorine is a toxic chemical. When inhaled in high concentration, chlorine gas causes suffocation, constriction of the chest, tightness in the throat and edema of the lungs. At around 1,000 parts per million (ppm), it is likely to be fatal after a few deep breaths. Depending on a number of factors—such as release volume, terrain, temperature, humidity, atmospheric stability and wind direction and speed—a chlorine gas plume can travel several miles in a short time at concentrations well above IDLH. Although the wind direction on the day of the release carried the majority of the chlorine plume away from neighboring residential areas, some areas were evacuated.

Hundreds of residents — including occupants of an assisted living facility and a learning center, (both part of the Jefferson Memorial Hospital system) and students at a local school — were sheltered-in-place for up to four hours. Interstate 55 traffic was shut down from 9:45 a.m. to 11:15 a.m. A total of 63 people in the surrounding community sought medical evaluation because of inhalation exposure to chlorine. Eight persons were administered oxygen. Three persons were kept overnight at Jefferson Memorial Hospital for observation of possible chlorine-induced pneumonia and were released the next day.

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[1] Investigation Report: Chlorine Release. United States Chemical Safety and Hazard Investigation Board (CSB) Case Study. Report No. 2002-04-I-MO. May 2003. <http://www.chemsafety.gov/>

[2] DPC Enterprises Chlorine Release. United States Chemical Safety and Hazard Investigation Board (CSB) Investigation Digest. http://www.chemsafety.gov/

Around 9:20 a.m. on Wednesday, August 14, 2002, a 1-inch chlorine transfer hose (CTH) used in a railroad tank car unloading operation at the DPC Enterprises, L.P., facility near Festus, Missouri, catastrophically ruptured.

At 9:27 a.m.— approximately seven minutes after the release began—the DPC operations manager called 911 to report the chlorine release. The Jefferson County R-7 volunteer fire department arrived on scene within ten minutes. The R-7 fire chief immediately requested 911 dispatch to notify mutual aid response fire departments and the Jefferson County hazardous materials (hazmat) unit.

A reconnaissance team of R-7 fire fighters was deployed to nearby businesses and a mobile home park to search for victims and assist in evacuation.

Highway 61 was shut down in both directions and separate command posts were set up on the highway (one by municipal authorities, the other by county responders).

A drive-through bull horn notification, followed by door-to-door evacuation, was conducted in the nearby neighborhood. It took emergency response personnel more than an hour to evacuate the areas.

The ambulance service transported six people from neighboring areas with symptoms of chlorine exposure to Jefferson Memorial.

The Jefferson County hazmat unit is made up of all volunteers, who live and work in various parts of the 660 square-mile county. The team duty officer received notification of the DPC release from 911 dispatch at 9:45 a.m., and the team was paged within 15 minutes. Although the south post was designated as the hazmat staging area, the response truck and several team members initially went to the north post.

Decontamination setup began at 11:00 a.m. Most of the team had arrived on scene by 11:15 a.m. It took 45 minutes to complete medical monitoring, entry team selection and site safety planning (including entry and exit) and to don PPE.

Hazmat responders measured chlorine concentrations of greater than 1,000 ppm at the release site, which is life-threatening without proper respiratory equipment.

Three hazmat personnel and one DPC employee (who had specialized hazmat training) entered the release area around noon, where a yellowish-green fog about 4 feet high covered the area surrounding the tank car. Visibility was very poor. Two hazmat personnel climbed the tank car ladder to access the top of the car. They closed the liquid valve that supplied the ruptured hose (valve A), but the release did not stop. They then closed the other liquid valve (valve C) and the vapor valve D halfway; then they completely closed both valves. The release stopped when valve C was closed.

The hazmat team surveyed the area surrounding the tank car and the repackaging building for other release sources. None was located. They identified a 4 x 4 foot formation of chlorine hydrate next to the tank car (underneath the ruptured hose) but it was determined to pose no imminent danger.

A majority of the emergency responders left the scene after the release was stopped. However, Highway 61 remained closed, and the evacuation order stayed in effect due to high levels of chlorine. Over the next several hours, the Missouri Department of Natural Resources conducted monitoring throughout the facility, as well as the neighboring community (MDNR, 2002).

Around 5:00 p.m., the Jefferson County R-7 fire department lifted the evacuation order and reopened Highway 61.

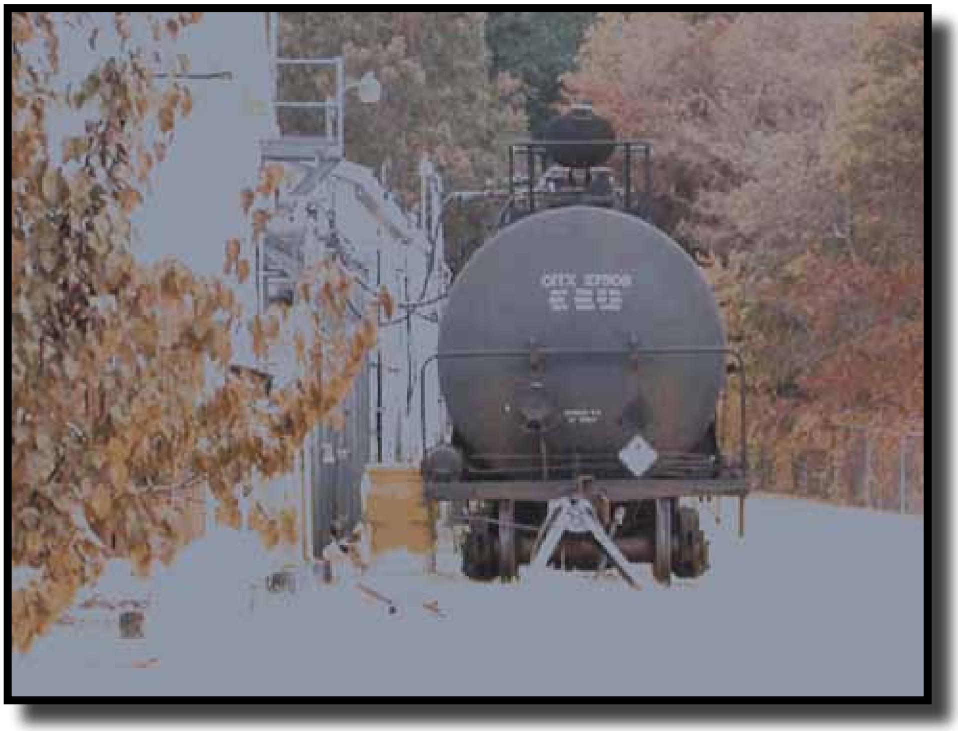
DPC began cleanup activities immediately after the R-7 fire department released the scene. The figure below shows the area of cleanup. Alarms were turned off, the chlorine piping system was evacuated and depressurized, and all fill stations were isolated.

In consultation with DPC corporate personnel, the operations manager decided to remediate the chlorine hydrate formation. No remediation plan was developed to formally review potential hazards. Three of the DPC packagers, wearing chlorine-resistant suits and carrying escape respirators, placed lime (calcium carbonate) on top of, and around, the ice formation. However, the material was not fully neutralized when the packagers attempted to place it into drums. The trapped liquefied chlorine was exposed to warm air and released as a gas.

The protective suits worn by the packagers provided only minimal protection because they were not fully encapsulating. The three men received minor skin exposure, and experienced numbness, itching and irritation of affected skin. All three men received medical evaluation.

The hydrate formation continued to give off minor amounts of chlorine gas for the next two days until an environmental remediation company completed the cleanup.

CSB does not question the DPC decision to evacuate the facility and request community emergency response assistance.



While local authorities have the primary responsibility for notifying the public of an emergency, the company shares responsibility for notifying and educating neighboring residents and businesses in advance on how to respond to an emergency.

DPC had procedures, and effectively notified local agencies and emergency response personnel of the release, but it did not adequately inform the public. The emergency response plan contained contact numbers for the LEPC, nearby businesses and neighbors—including the construction and tire retreading company, the mobile home park and the owner of an adjacent farm—but it did not assign responsibility for notification to any specific personnel. Emergency responders went door-to-door at the Blue Fountain mobile home park and in other nearby residential areas to notify residents of the release; this took over an hour. No procedures for evacuation or shelter-in-place had been given in advance to residents or businesses.

Although the DPC Festus facility evacuation procedures contained instructions for employee action during a release, they did not provide clear guidance on when facility emergency response personnel respond to a release, or when off-site community hazmat response is required. This lack of guidance explains the indecision among facility personnel responsible for assessing emergency response options.

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APIE Worksheet

Use this worksheet to work through the following what-if scenario for the Festus, MO case study.

What if you were called for a slow, rather than high-volume, release?

Analyze the Problem GOAL = Identify the Problem and Likely Behavior

Use the Chemical/Physical Properties Identification Form (next page) to help you collect the hazard information you'll need to predict behavior of hazmats and containers and estimate outcomes. Use the space below for your notes.

Type of Incident

☐ Fire/explosion ☐ Release ☐ Confined space ☐ Reactive chemicals

Initiate ICS ______________________________

____

Survey the Incident ______________________________

____

Collect Hazard and Response Information ______________________________

____

Identify Container Type(s) and Stress ______________________________

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Predict Behavior ______________________________

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Estimate Outcomes ______________________________

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Chemical/Physical Properties Identification Form

Product/Chemical Names:	References Used:

Chemical and Physical Properties

Physical State:	Form:	Vapor Pressure: mmHg/ATM
Flammable: Yes/No	LEL: %	UEL: %

Flash Point (Fl.P): ºF/C	Boiling Point (BP): ºF/C
Ignition (Auto) Temperature: ºF/C	

Molecular Weight (MW):		Vapor Density (VD):	
Lighter/Heavier than Air:		Volatility:	
Specific Gravity (Sp.Gr.);		Solubility (SOL):	
Corrosive: pH		Reactive (with):	
Polymerization (potential): Yes/No			
Radioactive: Yes/No	Alpha:	Beta:	Gamma:

Health

Toxic: Yes/No	Routes of Exposure: Inhalation/Absorption/Ingestion/Injection

Exposure Limits:	TLV-TWA:	TLV-STEL:
TLV-C:	PEL	IDLH:
Comments:		

Plan the Response

GOAL = Develop and Communicate the IAP

Use the space below for your notes.

Describe Response Objectives ________________________________

Determine Personnel/Equipment Needs ________________________________

Determine PPE Needs ________________________________

Describe Decon Issues ________________________________

Select Response Objectives ________________________________

Implement the Plan

GOAL = Observe Operations and Outcomes

Use the space below for your notes.

Establish and Enforce Scene Control ______________________________

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Perform Decon ______________________________

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Perform Protective Actions ______________________________

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Use PPE ______________________________

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Perform Control Options ______________________________

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Evaluate the Progress

GOAL = Assess Response Effectiveness

Use the space below for your notes.

Evaluate Response Status ____

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Communicate Response Status ____

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Dalton, GA — MFG Chemical, Inc. Case Study – Team 4[1]

On the night of April 12, 2004, during an attempt to make the first production batch of triallyl cyanurate (TAC) at MFG Chemical, Inc. (MFG) in Dalton, GA, a runaway chemical reaction released highly toxic and flammable allyl alcohol and allyl chloride vapors into the nearby community. The fire department ordered an evacuation of residents and businesses within a half-mile of the facility. The release forced more than 200 families from their homes. One MFG employee sustained minor chemical burns and 154 people received decontamination and treatment at the local hospital for chemical exposure, including 15 police and ambulance personnel assisting with the evacuation. Five residents required overnight hospitalization for breathing difficulties. The reactor continued venting toxic vapor for nearly eight hours and the evacuation order lasted more than nine hours.

MFG intended to synthesize triallyl cyanurate by reacting cyanuric chloride with allyl alcohol in the presence of a catalyst.

Allyl Alcohol + Cyanuric Chloride + Catalyst → TAC + Hydrogen Chloride + Catalyst

The reaction produces hydrogen chloride (HCl) as a by-product. In order to ensure complete conversion of the cyanuric chloride, the procedure specified an excess amount of allyl alcohol. MFG planned to synthesize fixed-volume batches of TAC using a 4,000-gallon reactor equipped with an external cooling-jacket.

The chemical addition sequence began when operators loaded the dry-powder cyanuric chloride into the reactor on Friday, April 9, 2004, three days before the allyl alcohol and the temporary reactor cooling system arrived. The allyl alcohol isotainer arrived in the afternoon on Monday, April 12, and was parked adjacent to the reactor. The engineering and compliance manager met with the operators and discussed the precautions and PPE required for the allyl alcohol transfer into the reactor. They then connected the transfer hose to the process piping. The operators concluded the chiller was providing sufficient cooling to the reactor because the reactor interior temperature reading was 32ºF and the reactor cooling-jacket and chiller piping were frost covered. They were finally ready to proceed with the remaining steps in the procedure.

The operators pumped the entire quantity of liquid catalyst through the liquid feed line into the dry chemical already in the reactor. They then transferred the allyl alcohol into the reactor by pressurizing the container with nitrogen.

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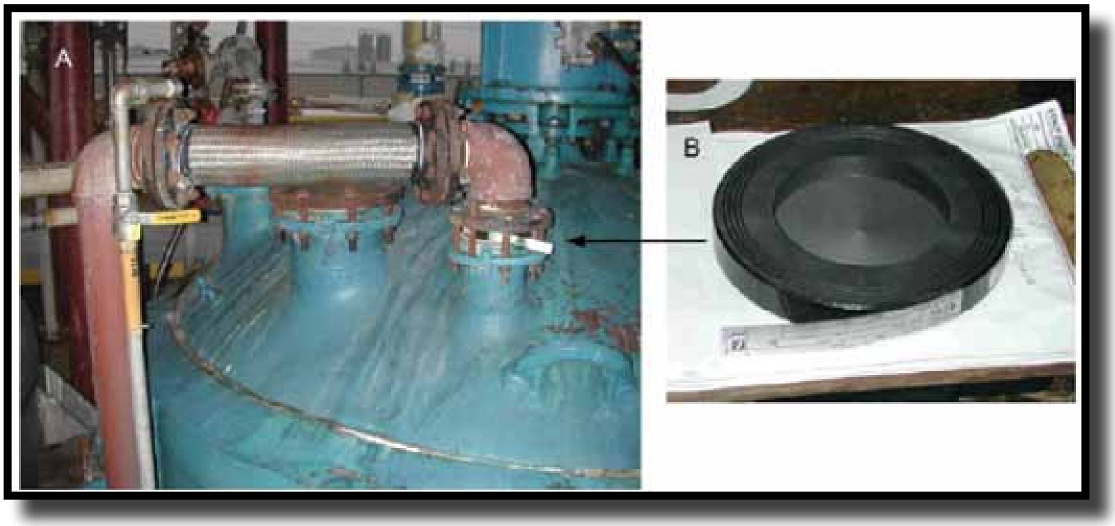
[1] Investigation Report: Toxic Chemical Vapor Cloud Release. United States Chemical Safety and Hazard Investigation Board (CSB) Case Study. Report No. 2004-09-I-GA. April 2006 <http://www.chemsafety.gov/>

After a few minutes of transferring allyl alcohol into the reactor through the transfer piping, they concluded that it was going to require many hours to complete the transfer at the established flow rate. Because the procedure did not restrict the allyl alcohol fill-rate, the operators increased the nitrogen pressure to speed the transfer. At the higher flow rate, they completed the transfer in less than an hour. The operators closed both transfer-hose isolation valves, but left the hose attached to the equipment. The reactor agitator had been started sometime during the transfer operation to mix the chemicals.

A short time after loading the allyl alcohol to the cyanuric chloride and the catalyst, the operators noticed the reactor temperature had increased from 32°F (0°C) to about 72°F (22°C), presumably due to the addition of the warm allyl alcohol. Ten minutes later, the operators noted that the temperature had already climbed to 103°F (39°C). The temperature continued to increase rapidly to 118ºF, well above the peak temperature of about 100°F (38°C) that they expected. Unknown to the engineers and operators, it was almost at the temperature at which the exothermic decomposition reaction occurs. Rapidly increasing pressure in the reactor caused the manway gasket to blow out. Dense, white vapor immediately began to spray out of the manway. The rupture disc (see below) blew open about 30 seconds later, sending additional white vapor out of the end of the 4-inch vent pipe near the base of the reactor. The last observed reactor temperature was 124°F (51°C).

Operators initially considered approaching the reactor manway to attempt to reseal the gasket, but the leak was too large to stop and the venting vapor was moving toward them. With two reactants and the catalyst fully charged into the reactor, no ability to increase cooling rate, no emergency dilution system and no reactor vent scrubber, they had no choice but to evacuate the area. All seven personnel safely evacuated the facility as the vapor cloud rapidly expanded and began drifting off-site to the north and east.



A 9:34 p.m. call informed the Whitefield County 911 Emergency Management Center that a chemical release involving allyl alcohol was occurring at the MFG Callahan Road facility. The emergency operator notified the Dalton City Fire Department dispatcher that there had been a chemical spill and the fire department should respond.

The Whitfield County Emergency Management Center (EMC) dispatcher informed the fire crew that they were to respond to a hazmat spill inside the building at the facility. The dispatcher advised them that the material spilled was allyl alcohol. Responding fire fighters unknowingly drove through the dense vapor cloud that was drifting over Lakeland Road, east of the facility. The acrid odor immediately irritated their eyes and nostrils.

Concluding that the incident was much more serious than merely a spill, they directed the other responding unit to take an alternate route to the facility and requested dispatch to call a chief officer to the incident scene. They also requested the dispatcher to alert the police department to dispatch police in preparation for a possible evacuation of residents. Fire crews also requested that the police close Lakeland Road, north and south of the facility. About ten minutes had elapsed from the start of the vapor release.

The first responding fire department lieutenant addressed the immediate concerns of the emergency responders and community. He notified dispatch that a precautionary evacuation of nearby residents might be needed, and reported the hazard placard identification number on the side of the isotainer to the dispatcher, confirming that allyl alcohol was the likely chemical involved. He then established an Incident Command Post outside the fence, at the southwest corner of the facility. The dispatcher then informed the IC that the DOT Emergency Response Guidebook (Guide 131) advises an evacuation distance of 4/10 of a mile for a large, nighttime allyl alcohol spill. The IC directed police to alert and evacuate the residents and businesses within a half mile downwind, north and east of the facility.

MFG personnel informed the IC that the reactor had overheated and they expressed concern that it needed cooling. They advised the IC to spray water on the releasing vapor cloud and reactor, and recommended the evacuation of the community downwind.

An ambulance crew, responding to a 911 call from a resident, informed the dispatcher that a strong chemical odor was noticeable as soon as they entered the neighborhood. Overcome by the vapor while walking from the ambulance to the resident's home, the EMT and paramedic retreated from the neighborhood.

The crew soon pulled off the road and radioed the dispatcher to request assistance. The toxic vapor affected both the EMT and paramedic, but only the EMT experienced a severe reaction that required long-term treatment. A second ambulance crew arrived and transported the stricken EMT and four residents who had stopped and requested medical aid to the hospital.

Thirteen minutes after the MFG call to 911 (9:47 p.m. Monday night) the police department began evacuating residents. Having no emergency sirens or other community-wide emergency alert system, police officers proceeded into the vapor-contaminated neighborhoods and used their PA system or went door-to-door as necessary, instructing residents to evacuate their homes. None of the responding police officers had the training or safety equipment needed to enter these neighborhoods, but no other notification method was available. Responding officers immediately reported a real thick chemical odor in the area.

All responding police officers reported to the dispatcher that they experienced severe eye, nose and throat discomfort as they approached the communities near the MFG facility. The police sergeant requested the fire department to provide personnel with self-contained breathing apparatus (SCBA) to take over the evacuation. The unprotected police officers reported extreme difficulty breathing. Twenty minutes into the evacuation, and after notification of continuing police officers distress, the fire department lieutenant directed the police officers to leave the area and SCBA-equipped response fire crews took over. Five police officers required transport to the hospital for decontamination and treatment for exposure to allyl alcohol vapor.

One of the MFG chemists called the Lyondell Emergency Response Manager in Houston, TX shortly after the fire department arrived on scene. The IC consulted with the Lyondell manager (Lyondell Chemical is the allyl alcohol manufacturer) throughout the incident response. Lyondell recommended that the fire department spray foam on the liquid pool beneath the reactor to help suppress the vapor cloud. Lyondell also suggested that MFG attempt to place a container of water under the rupture-disc vent pipe since it vented directly to the atmosphere rather than safely venting into a hazardous material containment device, such as a scrubber. They hoped that by discharging the vapor directly into the water, any allyl alcohol would dissolve in the water.

At 11:15 p.m., the IC directed the fire crews to make one more pass through the neighborhoods using their PA system to announce the evacuation. Three hours later, the IC extended the evacuation to the businesses and residents south and west of the MFG facility because of changing wind direction. The IC finally cancelled the evacuation order just before 7:00 a.m.

The fire department operated in an awareness-level response mode, performing defensive measures while remaining safely upwind of the toxic vapor because they did not have appropriate monitoring devices, PPE or a trained and equipped hazmat response team. They used a four-gas detector device to monitor the air for the following chemicals: hydrogen sulfide, carbon monoxide, flammable vapor and oxygen. Fire fighters used unmanned water cannons and directed the water flow on top of, and around the reactor, in an attempt to absorb the releasing vapor and to cool the reactor. The fire department decided not to use any vapor containment foam because the significant water volume spraying on the reactor would disrupt a foam cover and render it ineffective. Cooling the reactor was their first priority.

With the concurrence of the deputy fire chief, the IC permitted three MFG personnel to re-enter the building to check the reactor temperature, quickly observe the reactor equipment, check on the status of the reactor cooling system and retrieve their respirators from the building. The IC made it clear to the MFG personnel that they would enter at their own risk. Furthermore, the fire department would not attempt a rescue in the event that an employee was overcome by the vapor, or sustained serious injury during the entry since the fire department personnel did not have the protective equipment required for allyl alcohol exposure. Nevertheless, the inadequately protected MFG employees entered the facility without monitoring the allyl alcohol concentration in the air. After the first entry into the building, one MFG employee returned to the building to retrieve the MSDS for the fire department.

Two Dalton Utilities employees arrived at 11:18 p.m. and informed the IC that firewater runoff was entering the storm-water drainage canal that flowed into the nearby Stacey Branch creek. The IC decided that it was more important to minimize the airborne concentration of the chemical so they continued applying water to the reactor to knock down the vapor, acknowledging that contaminated water would enter the creek.

Shortly after 2:00 a.m., the IC again permitted MFG personnel wearing only Tyvek/Tychem suits, boots, gloves and full-face cartridge respirators to return to the process equipment to place a 5-gallon bucket filled with water under the rupture disc vent-pipe. The Lyondell Emergency Response Manager recommended this makeshift vapor scrubber to reduce the quantity of toxic vapor being released. However, the bucket had no effect on the continuing vapor release through the manway. The fire department did not monitor the air for toxic vapor concentration in the area during this activity.

At 5:30 a.m., more than seven hours after the release had started, the fire department concluded, based on visual observations and readings from four gas detector devices, that the vapor release had subsided sufficiently to permit them to stop the water spray. MFG personnel re-entered the building and began monitoring the reactor temperature. They forwarded the temperature data to the IC every 15 minutes.

Tuesday afternoon at 1:00 p.m., more than 15 hours after the incident began, the reactor had cooled to 70ºF and the reaction appeared to have ended. MFG personnel installed a new rupture disk, replaced the manway gasket and tightened the clamps. The IC terminated the fire department response activities since the reactor was resealed.

The fire department established a triage station at Fire Station 2, three miles north of the MFG facility. There, paramedics and emergency medical technicians (EMT) from the Hamilton Medical Center evaluated the injured. Police and fire crews directed individuals having significant difficulty breathing or complaining of burning sensations in their eyes, nose and throat to the triage stations. Over the next two hours, an EMS ambulance crew made seven trips to the hospital, three miles north of the triage station. They transported 35 patients, including two EMS employees and the five injured police officers.

The EMC dispatcher alerted the Hamilton Medical Center emergency room to prepare for people exposed to allyl alcohol. Emergency room personnel investigated the potential health impacts as well as the appropriate decontamination and treatment, and prepared a fact sheet for use by their personnel. The on-call emergency room physician consulted with the Georgia Poison Control Center, and reviewed the allyl alcohol MSDS.

The Hamilton Medical Center declared a code yellow event at 10:29 p.m., activating the Mass Casualty Plan. Emergency room personnel set up a decontamination station outside the hospital. Decontamination consisted of disrobing, then rinsing the entire body with a cool water spray. Although hospital personnel did not collect and handle the potentially contaminated water, there was no reported environmental damage at the hospital. Hospital personnel placed personal belongings in sealed plastic bags and returned them to the owners with instructions for cleaning to remove residual allyl alcohol.

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APIE Worksheet

Use this worksheet to work through the following what-if scenario for the Dalton, GA case study.

What if you were called for a run-away reaction during the production of one of the smaller, trial batches?

Analyze the Problem GOAL = Identify the Problem and Likely Behavior

Use the Chemical/Physical Properties Identification Form (next page) to help you collect the hazard information you'll need to predict behavior of hazmats and containers and estimate outcomes. Use the space below for your notes.

Type of Incident

☐ Fire/explosion ☐ Release ☐ Confined space ☐ Reactive chemicals

Initiate ICS ____

____

Survey the Incident ____

____

Collect Hazard and Response Information ____

____

Identify Container Type(s) and Stress ____

____

Predict Behavior ____

____

Estimate Outcomes ____

____

Chemical/Physical Properties Identification Form

Product/Chemical Names:	References Used:

Chemical and Physical Properties

Physical State:	Form:	Vapor Pressure: mmHg/ATM
Flammable: Yes/No	LEL: %	UEL: %

Flash Point (Fl.P): ºF/C	Boiling Point (BP): ºF/C
Ignition (Auto) Temperature: ºF/C	

Molecular Weight (MW):		Vapor Density (VD):	
Lighter/Heavier than Air:		Volatility:	
Specific Gravity (Sp.Gr.);		Solubility (SOL):	
Corrosive: pH		Reactive (with):	
Polymerization (potential): Yes/No			
Radioactive: Yes/No	Alpha:	Beta:	Gamma:

Health

Toxic: Yes/No	Routes of Exposure: Inhalation/Absorption/Ingestion/Injection

Exposure Limits:	TLV-TWA:	TLV-STEL:
TLV-C:	PEL	IDLH:
Comments:		

Plan the Response

GOAL = Develop and Communicate the IAP

Use the space below for your notes.

Describe Response Objectives ______________________________

____

____

Determine Personnel/Equipment Needs ______________________________

____

____

Determine PPE Needs ______________________________

____

____

Describe Decon Issues ______________________________

____

____

Select Response Objectives ______________________________

____

____

Implement the Plan

GOAL = Observe Operations and Outcomes

Use the space below for your notes.

Establish and Enforce Scene Control ____________________

____

____

Perform Decon ____________________

____

____

Perform Protective Actions ____________________

____

____

Use PPE ____________________

____

____

Perform Control Options ____________________

____

____

Evaluate the Progress

GOAL = Assess Response Effectiveness

Use the space below for your notes.

Evaluate Response Status ____

____

____

____

Communicate Response Status ____

____

____

____

____

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Appendices

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Table of Contents

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Appendix A: Supplemental Information

Hazmat References

During this course, the following references will be used to collect hazard and response information to analyze the problem at incidents in the chemical process industry.

- 2008 Emergency Response Guidebook
- NIOSH Pocket Guide to Chemical Hazards
- Material Safety Data Sheets (MSDSs)

First responders at the operations level should be familiar with using these references. Below and on the pages that follow, you will find a basic description of each reference, and the type of information it can provide a first responder.

2008 Emergency Response Guidebook (ERG)

The ERG is designed to provide first responders with identification of the specific and/or generic hazards of materials that may be involved at a hazmat incident. You should be familiar with the guide before an incident occurs. If necessary, review pages 1 – 24 of the ERG to learn:

- Three ways to determine the appropriate guidebook page — the numerical index, alphabetical index and the table of placards and initial response guides
- The information provided in the orange-bordered pages of the ERG — potential hazards, public safety measures and emergency response actions
- The information provided in the green-bordered pages of the ERG — initial isolation and protective action distances (Table 1) and materials which produce large amounts of toxic inhalation hazard (TIH) when spilled in water

NIOSH Pocket Guide to Chemical Hazards

The NIOSH Pocket Guide includes:

- Chemical name
- Immediately dangerous to life or health (IDLH) concentrations from which a worker could escape without injury or irreversible health effects for a 30-minute exposure
- Department of Transportation (DOT) identification numbers and guide numbers for the ERG
- Synonyms and trade names
- Exposure limits
- Physical descriptions
- Chemical and physical properties including molecular weight (MW), boiling point (BP), solubility (Sol), flash point (FI.P), ionization potential (IP), specific gravity (Sp.Gr.), relative density of gases (RGasD), vapor pressure (VP), freezing point (FRZ), melting point (MLT), upper explosive (flammable) limit (UEL), lower explosive (flammable) limit (LEL) and minimum explosive concentration
- Personal protection including personal protective clothing and eye protection
- Recommendations for respirator selection
- Incompatibilities and reactivities
- Exposure limits, symptoms and target organs
- First aid

To learn more, review pages vii – xvi of the NIOSH Pocket Guide.

Material Safety Data Sheets (MSDSs)

First responders at the operations level should also be able to identify where to find an MSDS and the major sections of an MSDS:

- Manufacturer’s name and location
- Name and family of the chemical
- Hazardous ingredients
- Physical data
- Fire and explosion hazard data
- Health hazard data
- Reactivity data
- Spill or leak procedures
- Special protection information
- Special precautions

You should also be able to find the following on MSDSs:

- First aid measures
- Fire fighting measures
- Accidental release measures
- Handling and storage
- Exposure controls/personal protection
- Toxicological information

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Module 1 – Introduction

Reference Materials for Methyl Isocyanate

The following response information on methyl isocyanate have been obtained from:

- Computer-Aided Management of Emergency Operations (CAMEO)
- Chemical Hazards Response Information System (CHRIS) manual

Print

CAMEO Chemicals

Chemical Datasheet

METHYL ISOCYANATE

3
4 2
~~W~~

Chemical Identifiers

UN/NA Number	CAS Number	CHRIS Code	DOT Hazard Label
2480	624-83-9	MIS	POISON FLAMMABLE LIQUID

NFPA 704: Red 3 -- Flammability: Ignites at normal temperatures
Blue 4 -- Health Hazard: Too dangerous to enter - vapor or liquid
Yellow 2 -- Reactivity: Violent chemical change possible
White ~~W~~ -- Special: Unusually reactive with water

General Description

A colorless low-boiling liquid (b. p. 39°C) that is denser than water. Flash point is less than 20° F. Very toxic by inhalation. Can be absorbed through the skin. Has a sharp odor, but the sense of smell cannot be relied upon to warn of the presence of vapors at low concentrations.

Rate of onset: Immediate

Persistence: Minutes to hours

Odor threshold: 2.1 ppm

Source/use/other hazard: Intermediate in manufacturing; reacts with H20 (don’t use in fire).

Hazards

Reactivity Alerts

⚠ Highly Flammable

- ⚠ Polymerizable
- ⚠ Water-Reactive

Air & Water Reactions

Highly flammable. Reacts exothermically with water to produce carbon dioxide, methylamine, dimethylurea and/or trimethylbiuret. Heat of reaction causes evolution of the vapors of the isocyanate. Reaction is relatively slow below 20°C but becomes violent at more elevated temperatures or in the presence of acids and bases.

Fire Hazard

Reacts violently with water. Extremely flammable; may be ignited by heat, sparks, or flames. Vapors may travel to a source of ignition and flash back. Container may explode violently in heat of fire. Vapor explosion and poison hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. When heated to decomposition, it emits toxic fumes of nitrogen oxides. Avoid water, acids, alkali, amines, iron, tin, copper, and other catalysts. Avoid heat, flame, oxidizers, water. Hazardous polymerization may occur. Methyl isocyanate (MIC) will react with water, or in the presence of catalysts (such as sodium hydroxide, sodium methoxide, triphenylarsine, triethyl phosphine, metallic chlorides) to form either a cyclic trimer (trimethyl isocyanurate) or a gummy, resinous polymer. These reactions are exothermic, producing about 540 Btu per pound of MIC. Heat produced in these reactions may result in pressure build up and rupturing of tanks. (EPA, 1998)

Health Hazard

This compound is a skin irritant and can cause permanent eye damage. A concentration of 2 ppm has been reported toxic in humans. Methyl isocyanate attacks the respiratory system, eyes and skin. It can injure the lungs and bronchial airways, cause permanent eye damage, and death. Death has been attributed to various forms of respiratory distress. (EPA, 1998)

Reactivity Profile

Airborne vapors of METHYL ISOCYANATE are explosive when exposed to heat, flame or sparks. Vapor may ignite on contact with strong oxidizing agents. Emits toxic fumes of nitriles and oxides of nitrogen when heated to decomposition [Lewis, 3rd ed., 1993, p. 860]. Caused the death of thousands in 1984 in Bhopal, India when released accidentally as a vapor following an exothermic reaction caused by contamination with water [Chem. Eng. News, 1985, 63(6), p. 27]. Reacts rapidly with acids and bases (including amines). May polymerize in contact with iron, tin, copper and certain other catalysts such as triphenylarsenic oxide, triethyl phosphine and tributyltin oxide. Polymerizes at elevated temperatures. Attacks some plastics, rubbers, and coatings [NTP].

Belongs to the Following Reactive Group(s)

- Isocyanates and Isothiocyanates, Organic

Response Recommendations

Firefighting

Material is extremely hazardous to health but areas may be entered with extreme care. Full protective clothing, including self-contained breathing apparatus (coat, pants, gloves, boots, and bands around legs, arms and waist) should be provided. No skin surface should be exposed. Stay away from ends of tanks. Do not get water inside container. Spray cooling water on containers that are exposed to flames until well after fire is out. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire.

Small fires: dry chemical, carbon dioxide, water spray, or foam. Large fires: water spray, fog, or foam. (EPA, 1998)

Non-Fire Response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. (AAR, 2003)

Protective Clothing

Skin: Wear appropriate personal protective clothing to prevent skin contact.

Eyes: Wear appropriate eye protection to prevent eye contact.

Wash skin: The worker should immediately wash the skin when it becomes contaminated.

Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point < 100°F)

Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.

Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.] (NIOSH, 2003)

_____Dupont Average Standardized Breakthrough Times_____
(for METHYL ISOCYANATE)

Tychem® BR
greater than 480 min. (concentration: 95+%)
Tychem® CPF2
immediate (less than 10 min.) (concentration: 95+%)
Tychem® CPF3
12 min. (concentration: 95+%)
Tychem® CPF4
greater than 480 min. (concentration: 90%)
Tychem® LV
greater than 480 min. (concentration: 95+%)
Tychem® Reflector®
greater than 480 min. (concentration: 95+%)
Tychem® Responder®
greater than 480 min. (concentration: 95+%)
Tychem® Responder® CSM
greater than 480 min. (concentration: 95+%)
Tychem® SL
immediate (less than 10 min.) (concentration: 95+%)
Tychem® ThermoPro
immediate (less than 10 min.) (concentration: 100%)
Tychem® TK
greater than 480 min. (concentration: 95+%) (DuPont, 2008)

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First Aid

Warning: Effects may be delayed for up to 15 hours. Caution is advised.

Signs and Symptoms of Acute Methyl Isocyanate Exposure: Acute exposure to methyl isocyanate may result in respiratory tract irritation, cough, chest tightness and pain, dyspnea (shortness of breath), asthmatic episodes, and pulmonary edema. Contact with the skin, eyes, and mucous membranes may result in severe irritation and permanent damage.

Emergency Life-Support Procedures: Acute exposure to methyl isocyanate may require decontamination and life support for the victims. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination.

Inhalation Exposure:
1. Move victims to fresh air. Emergency personnel should avoid self-exposure to methyl isocyanate.
2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
3. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
4. Transport to a health care facility.

Dermal/Eye Exposure:
1. Remove victims from exposure. Emergency personnel should avoid self- exposure to methyl isocyanate.
2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
3. Remove contaminated clothing as soon as possible.
4. If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 15 minutes.
5. Wash exposed skin areas twice with soap and water.
6. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
7. Transport to a health care facility.

Ingestion Exposure:
1. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
2. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
3. Activated charcoal may be administered if victims are conscious and alert. Use 15 to 30 g (1/2 to 1 oz) for children, 50 to 100 g (1-3/4 to 3-1/2 oz) for adults, with 125 to 250 mL (1/2 to 1 cup) of water.
4. Promote excretion by administering a saline cathartic or sorbitol to conscious and alert victims. Children require 15 to 30 g (1/2 to 1 oz) of cathartic; 50 to 100 g (1-3/4 to 3-1/2 oz) is recommended for adults.
5. Transport to a health care facility. (EPA, 1998)

Physical Properties

Molecular Formula: C2H3NO

Flash Point: 19.0 ° F (EPA, 1998)

Lower Explosive Limit: 5.3 % (EPA, 1998)

Upper Explosive Limit: 26.0 % (EPA, 1998)

Autoignition Temperature: 995.0 ° F (USCG, 1999)

Melting Point: -112.0 ° F (EPA, 1998)

Vapor Pressure: 348.0 mm Hg at 68.0 ° F (EPA, 1998)

Vapor Density: About twice as heavy as air (EPA, 1998)

Specific Gravity: 0.9599 at 68.0 ° F (EPA, 1998)

Boiling Point: 102.0 ° F at 760 mm Hg (EPA, 1998)

Molecular Weight: 57.05 (EPA, 1998)

Water Solubility: Decomposes (NTP, 1992)

AEGL-1	AEGL-2	AEGL-3
NR = Not recommended since AEGL-1 irritation levels would exceed AEGL-2	0.4 ppm for 10 minutes 0.13 ppm for 30 minutes 0.067 ppm for 60 minutes 0.017 ppm for 4 hours 0.008 ppm for 8 hours	1.2 ppm for 10 minutes 0.4 ppm for 30 minutes 0.2 ppm for 60 minutes 0.05 ppm for 4 hours 0.025 ppm for 8 hours
(AEGL, 2003)		

ERPG-1	ERPG-2	ERPG-3
0.025 ppm	0.25 ppm	1.5 ppm
(AIHA, 2008)		

TEEL: data unavailable

IDLH: 3.0 ppm (NIOSH, 2003)

Regulatory Information

Regulatory Names: METHANE, ISOCYANATO-
METHYL ISOCYANATE

CAA RMP: Regulated chemical with a Threshold Quantity of 10000 pounds.

CERCLA: Regulated chemical with a Reportable Quantity of 10 pounds.

EHS (EPCRA 302): Regulated chemical with a Reportable Quantity of 10 pounds and a Threshold Planning Quantity of 500 pounds.

TRI (EPCRA 313): Regulated chemical.

RCRA Chemical Code: P064

Alternate Chemical Names

- ISO-CYANATOMETHANE
- ISOCIANATO DE METILO (DOT SPANISH)
- ISOCYANATE DE MÉTHYLE (DOT FRENCH)
- ISOCYANATOMETHANE
- ISOCYANIC ACID, METHYL ESTER
- METHANE, ISOCYANATO-
- METHYL CARBONIMIDE
- METHYL ESTER ISOCYANIC ACID
- METHYL ESTER OF ISOCYANIC ACID
- MIC
- RCRA WASTE NUMBER P064
- TL 1450

METHYL ISOCYANATE

MIS

CAUTIONARY RESPONSE INFORMATION

Common Synonyms
Isocyanatomethane
Isocyanic acid, methyl ester
Methane, isocyanato-
Methyl carbonimide
MIC

Liquid | Colorless | Sharp, unpleasant odor

Floats; slowly mixes and slowly reacts with water at 20°C.

KEEP PEOPLE AWAY. AVOID CONTACT WITH LIQUID AND VAPOR.
EVACUATE AREA.
Wear chemical protective suit with self-contained breathing apparatus.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to ``knock down'' vapor.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
POISONOUS GASES/VAPORS ARE PRODUCED IN FIRE.
Containers may explode in fire.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
WEAR CHEMICAL PROTECTIVE SUIT WITH SELF-CONTAINED BREATHING APPARATUS.
Extinguish small fires: dry chemical, CO_2, water spray or foam; large fires: water spray, fog or foam.
Combat fires from safe distance or protected location.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
POISONOUS IF INHALED OR IF SKIN EXPOSED.
May cause fatal pulmonary edema.
Respiratory distress cited for most deaths.
Severely irritating to eyes.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.
Liquid
POISONOUS IF SWALLOWED OR IF SKIN EXPOSED.
Causes eye injury and skin burns.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of running water for at least 15 minutes.
IF IN EYES, hold eyelids open and flush with plenty of running water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink a large quantity of water and induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge

2. CHEMICAL DESIGNATIONS

2.1 **CG Compatibility Group:** Not listed.
2.2 **Formula:** CH_3NCO
2.3 **IMO/UN Designation:** 3.2/2480
2.4 **DOT ID No.:** 2480
2.5 **CAS Registry No.:** 624-83-9
2.6 **NAERG Guide No.:** 155
2.7 **Standard Industrial Trade Classification:** 51489

3. HEALTH HAZARDS

3.1 **Personal Protective Equipment:** Positive pressure breathing apparatus and special protective clothing.
3.2 **Symptoms Following Exposure:** INHALATION: Poisonous; may be fatal if inhaled. Experimental exposure of four human subjects for 1 to 5 minutes to: 0.4 ppm - no effects; 2 ppm - irritation of nose and throat; 4 ppm - irritation more marked; 21 ppm - unbearable irritation of nose and throat. High concentrations can cause burning sensations in the nose and throat, coughing, dyspnea (difficult or painful breathing, gasping for breath), increased secretions, lung injury and subsequent pulmonary edema and uncontrollable vomiting. Most deaths (Bhopal, India, 1984) have been attributed to various forms of respiratory distress such as massive accumulation of fluid in the lungs or spasmodic contrictions of the bronchial tubes.
3.3 **Treatment of Exposure:** INHALATION: Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Remove and isolate contaminated clothing and shoea at the site. EYES AND SKIN: Immediately flush eyes or skin with running water for at least 15 minutes, hold eyelids open occasionally, if appropriate. INGESTION: IF CONSCIOUS, give victim large quantities of water and induce vomiting by having victim touch the back of his throat. IF UNCONSCIOUS, do nothing except keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.
3.4 **TLV-TWA:** 0.02 ppm
3.5 **TLV-STEL:** Not listed.
3.6 **TLV-Ceiling:** Not listed.
3.7 **Toxicity by Ingestion:** Grade 3; LD_{50} = 71 mg/kg (rat)
3.8 **Toxicity by Inhalation:** Currently not available.
3.9 **Chronic Toxicity:** Susceptible individuals may become sensitized so that subsequent exposure to extremely low concentrations provoke true asthma attacks. Cross sensitization to other isocyanates could also occur.
3.10 **Vapor (Gas) Irritant Characteristics:** Vapors cause severe irritation of eyes and throat and can cause eye and lung injury. They cannot be tolerated even at low concentrations.
3.11 **Liquid or Solid Characteristics:** Severe skin irritant. Causes second and third-degree burns on short contact and is very injurious to the eyes.
3.12 **Odor Threshold:** Currently not available
3.13 **IDLH Value:** 3 ppm
3.14 **OSHA PEL-TWA:** 0.02 ppm
3.15 **OSHA PEL-STEL:** Not listed.
3.16 **OSHA PEL-Ceiling:** Not listed.
3.17 **EPA AEGL:** Not listed

4. FIRE HAZARDS

4.1 **Flash Point:** Currently not available
4.2 **Flammable Limits in Air:** 5.3% - 26%
4.3 **Fire Extinguishing Agents:** Small fires: dry chemical, CO_2, water spray or foam; large fires: water spray, fog or foam.
4.4 **Fire Extinguishing Agents Not to Be Used:** Not pertinent
4.5 **Special Hazards of Combustion Products:** Contain toxic and irritating gases, including HCN and NOx.
4.6 **Behavior in Fire:** Very flammable; may be ignited by heat, sparks or flames. May travel to a source of ignition and flashback. Container may explode violently.
4.7 **Auto Ignition Temperature:** 995°F.
4.8 **Electrical Hazards:** Currently not available
4.9 **Burning Rate:** Currently not available
4.10 **Adiabatic Flame Temperature:** Currently not available
4.11 **Stoichometric Air to Fuel Ratio:** 15.5 (calc.)
4.12 **Flame Temperature:** Currently not available
4.13 **Combustion Molar Ratio (Reactant to Product):** 4.5 (calc.)
4.14 **Minimum Oxygen Concentration for Combustion (MOCC):** Not listed

5. CHEMICAL REACTIVITY

5.1 **Reactivity with Water:** Reacts slowly with water at room temperature (20°C) to produce gaseous CO_2, methylamine (b.p. -6°C.) and heat (about 585 Btu per lb of methyl isocyanate or about 3,700 Btu per lb of water). Resulting pressure increase may cause relief valves to open. Acids, alkalies and amides accelerate the reaction. Reactivity accelerates as temperature rises.
5.2 **Reactivity with Common Materials:** Avoid contact with all metals other than stainless steel and nickel. The metals may catalyze polymerization reactions. The heat of reaction can cause the trimerization to occur with explosive violence. Also attacks some plastics, rubber and coatings. Glass-lined containers (no pinholes) and fluorocarbon resin-lined transfer hoses are acceptable.
5.3 **Stability During Transport:** Drums may be stored at ambient temperatures out of direct sun. Keep as cool as practical and away from sources of heat, sparks, or flames. Protected from all contaminants. Cool bulk quantities to about 0°C.
5.4 **Neutralizing Agents for Acids and Caustics:** Caustic soda
5.5 **Polymerization:** Pure methyl isocyanate polymerizes spontaneously. Commercial product requires only heat or a trace of catalyst to initiate a potentially violent reaction.
5.6 **Inhibitor of Polymerization:** No inhibitor identified as such. Residual trace phosgene from production inhibits polymerization and reaction with water.

6. WATER POLLUTION

6.1 **Aquatic Toxicity:** Currently not available
6.2 **Waterfowl Toxicity:** Currently not available
6.3 **Biological Oxygen Demand (BOD):** Currently not available
6.4 **Food Chain Concentration Potential:** Not pertinent
6.5 **GESAMP Hazard Profile:**
Bioaccumulation: 0
Damage to living resources: -
Human Oral hazard: 2
Human Contact hazard: II
Reduction of amenities: XXX

7. SHIPPING INFORMATION

7.1 **Grades of Purity:** Commercial (99%)
7.2 **Storage Temperature:** It is recommended that bulk quantities be cooled to approximately 0°C. Drums may be stored at ambient temperature out of direct sunlight. Storage temperature should not exceed 30°C.
7.3 **Inert Atmosphere:** Must be protected by a dry nitrogen (dew point -40°C. or lower) atmosphere.
7.4 **Venting:** Not listed
7.5 **IMO Pollution Category:** Currently not available
7.6 **Ship Type:** Currently not available
7.7 **Barge Hull Type:** Currently not available

8. HAZARD CLASSIFICATIONS

8.1 **49 CFR Category:** Poison
8.2 **49 CFR Class:** 6.1
8.3 **49 CFR Package Group:** I
8.4 **Marine Pollutant:** No
8.5 **NFPA Hazard Classification:** Not listed
8.6 **EPA Reportable Quantity:** 10 pounds
8.7 **EPA Pollution Category:** A
8.8 **RCRA Waste Number:** P064
8.9 **EPA FWPCA List:** Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 **Physical State at 15° C and 1 atm:** Liquid
9.2 **Molecular Weight:** 57.05
9.3 **Boiling Point at 1 atm:** 102.4°F. = 39.1°C. = 312.3°K
9.4 **Freezing Point:** <-112°F. = <-80°C. = <193°K.
9.5 **Critical Temperature:** 424°F. = 218°C. = 491°K.
9.6 **Critical Pressure:** 808 psia = 55 atm = 5.6 MN/m^2
9.7 **Specific Gravity:** 0.9599 at 20°C. (liquid)
9.8 **Liquid Surface Tension:** Currently not available
9.9 **Liquid Water Interfacial Tension:** Currently not available
9.10 **Vapor (Gas) Specific Gravity:** 2.0
9.11 **Ratio of Specific Heats of Vapor (Gas):** Currently not available
9.12 **Latent Heat of Vaporization:** 223 Btu/lb = 124 cal/g = 5.19×10^5 J/kg
9.13 **Heat of Combustion:** 8,041 Btu/lb = 4,467 cal/g = 1.87×10^7 J/kg
9.14 **Heat of Decomposition:** Not pertinent
9.15 **Heat of Solution:** Not pertinent
9.16 **Heat of Polymerization:** -540 Btu/lb = -300 cal/g = -12.56×10^5 J/kg
9.17 **Heat of Fusion:** Currently not available
9.18 **Limiting Value:** Currently not available
9.19 **Reid Vapor Pressure:** Currently not available

NOTES

9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square foot-F	Temperature (degrees F)	Centipoise
68	59.800		CURRENTLY NOT AVAILABLE		CURRENTLY NOT AVAILABLE		CURRENTLY NOT AVAILABLE

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	REACTS SLOWLY	68	6.730	68	0.06800		CURRENTLY NOT AVAILABLE

Title III of Superfund Amendments and Reauthorization Act (SARA) of 1986

Sections that are particularly applicable to emergency response personnel are listed below:

- Section 126 sets training requirements and other occupational safety and health standards for emergency response personnel who may be exposed to hazardous substances.
- Section 301 establishes the State Emergency Response Commissions (SERC), Regional Planning Districts and Local Emergency Planning Committees (LEPC) that are involved with emergency response planning for extremely hazardous substances.
- Section 302 requires the Environmental Protection Agency (EPA) to publish a List of Extremely Hazardous Substances (EHS) together with threshold planning quantities (TPQ) to trigger emergency response planning by states and local communities.
- Section 304 requires emergency notification of authorities when hazardous substances are released.
- Section 312 requires facilities to submit inventories and Material Safety Data Sheets (MSDSs) for hazardous substances to SERCs, LEPCs and fire departments, and allows fire departments to conduct on-site inspections.

Clean Air Act Amendments (CAAA) of 1990

Section 112(r) of CAAA requires the EPA to publish rules covering prevention, detection and responses to such releases. Application of these rules must be based on a list of threshold quantities for substances that are toxic, flammable or explosive. The EPA's 1996 Risk Management Program (RMP) under Clean Air Act Section 112(r)(7) requires the following information from all affected sources:

- A five-year history of accidental releases of substances subject to the RMP regulation that have resulted in injury or death to humans, off-site evacuations or property/environmental damage
- Hazard assessment of worst-case releases of toxic or flammable substances and, for some sources, alternative release scenarios
- Summary of the facility's emergency response program, including procedures for notifying the public of a release, and schedules for drills completed and planned
- Contact information for emergencies
- Date of the last safety inspection and the performing agency
- General description of the company's prevention plan

The 1999 amendments to the Chemical Accident Prevention Rule required stationary sources subject to the rule to submit an RMP by June 21, 1999. As of 2000, approximately 15,000 facility reports had been received.

Section 304 of CAAA requires the Occupational Safety and Health Administration (OSHA) to publish a chemical process safety standard, including a list with threshold quantities for Highly Hazardous Chemicals (HHC) to protect employees against catastrophic incidents involving toxic, flammable, highly reactive and explosive substances. This regulation has been published by OSHA as 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals. The total number of United States facilities covered under the OSHA regulation is not known because covered facilities are not required to identify themselves to the government.

OSHA List of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory)

29 CFR 1910.119 Appendix A – Listing of toxic and reactive highly hazardous chemicals which present a potential for a catastrophic event at or above the threshold quantity.

CHEMICAL NAME	CAS*[1]	TQ**[2]
Acetaldehyde	75-07-0	2500
Acrolein (2-Popenal)	107-02-8	150
Acrylyl Chlorde	814-68-6	250
Allyl Chlorid	107-05-1	1000
Allylamine	107-11-9	1000
Alkylaluminum	Varies	5000
Ammonia, Anhydrous	7664-41-7	10000
Ammonia solutions (greater than 44% ammonia by weight)	7664-41-7	15000
Ammonium Perchlorate	7790-98-9	7500
Ammonium Permanganate	7787-36-2	7500
Arsine (also called Arsenic Hydride)	7784-42-1	100
Bis(Chloromethyl) Ether	542-88-1	100
Boron Trichloride	10294-34-5	2500
Boron Trifluoride	7637-07-2	250
Bromine	7726-95-6	1500
Bromine Chloride	13863-41-7	1500
Bromine Pentafluoride	7789-30-2	2500
Bromine Trifluoride	7787-71-5	15000
3-Bromopropyne (also called Propargyl Bromide)	106-96-7	100
Butyl Hydroperoxide (Tertiary)	75-91-2	5000
Butyl Perbenzoate (Tertiary)	614-45-9	7500

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[1] Chemical Abstract Service Number

[2] Threshold Quantity in Pounds (Amount necessary to be covered by this standard.)

Carbonyl Chloride (see Phosgene)	75-44-5	100
Carbonyl Fluoride	353-50-4	2500
Cellulose Nitrate (concentration greater than 12.6% nitrogen	9004-70-0	2500
Chlorine	7782-50-5	1500
Chlorine Dioxide	10049-04-4	1000
Chlorine Pentrafluoride	13637-63-3	1000
Chlorine Trifluoride	7790-91-2	1000
Chlorodiethylaluminum (also called Diethylaluminum Chloride)	96-10-6	5000
1-Chloro-2,4-Dinitrobenzene	97-00-7	5000
Chloromethyl Methyl Ether	107-30-2	500
Chloropicrin	76-06-2	500
Chloropicrin and Methyl Bromide mixture	None	1500
Chloropicrin and Methyl Chloride mixture	None	1500
Cumene Hydroperoxide	80-15-9	5000
Cyanogen	460-19-5	2500
Cyanogen Chloride	506-77-4	500
Cyanuric Fluoride	675-14-9	100
Diacetyl Peroxide (concentration greater than 70%)	110-22-5	5000
Diazomethane	334-88-3	500
Dibenzoyl Peroxide	94-36-0	7500
Diborane	19287-45-7	100
Dibutyl Peroxide (Tertiary)	110-05-4	5000
Dichloro Acetylene	7572-29-4	250
Dichlorosilane	4109-96-0	2500
Diethylzinc	557-20-0	10000
Diisopropyl Peroxydicarbonate	105-64-6	7500
Dilauroyl Peroxide	105-74-8	7500
Dimethyldichlorosilane	75-78-5	1000
Dimethylhydrazine, 1,1-	57-14-7	1000
Dimethylamine, Anhydrous	124-40-3	2500
2,4-Dinitroaniline	97-02-9	5000
Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone Peroxide; concentration greater than 60%)	1338-23-4	5000

Ethyl Nitrite	109-95-5	5000
Ethylamine	75-04-7	7500
Ethylene Fluorohydrin	371-62-0	100
Ethylene Oxide	75-21-8	5000
Ethyleneimine	151-56-4	1000
Fluorine	7782-41-4	1000
Formaldehyde (Formalin)	50-00-0	1000
Furan	110-00-9	500
Hexafluoroacetone	684-16-2	5000
Hydrochloric Acid, Anhydrous	7647-01-0	5000
Hydrofluoric Acid, Anhydrous	7664-39-3	1000
Hydrogen Bromide	10035-10-6	5000
Hydrogen Chloride	7647-01-0	5000
Hydrogen Cyanide, Anhydrous	74-90-8	1000
Hydrogen Fluoride	7664-39-3	1000
Hydrogen Peroxide (52% by weight or greater)	7722-84-1	7500
Hydrogen Selenide	7783-07-5	150
Hydrogen Sulfide	7783-06-4	1500
Hydroxylamine	7803-49-8	2500
Iron, Pentacarbonyl	13463-40-6	250
Isopropylamine	75-31-0	5000
Ketene	463-51-4	100
Methacrylaldehyde	78-85-3	1000
Methacryloyl Chloride	920-46-7	150
Methacryloyloxyethyl Isocyanate	30674-80-7	100
Methyl Acrylonitrile	126-98-7	250
Methylamine, Anhydrous	74-89-5	1000
Methyl Bromide	74-83-9	2500
Methyl Chloride	74-87-3	15000
Methyl Chloroformate	79-22-1	500
Methyl Ethyl Ketone Peroxide (concentration greater than 60%)	1338-23-4	5000
Methyl Fluoroacetate	453-18-9	100
Methyl Fluorosulfate	421-20-5	100
Methyl Hydrazine	60-34-4	100
Methyl Iodide	74-88-4	7500
Methyl Isocyanate	624-83-9	250
Methyl Mercaptan	74-93-1	5000
Methyl Vinyl Ketone	79-84-4	100
Methyltrichlorosilane	75-79-6	500
Nickel Carbonly (Nickel Tetracarbonyl)	13463-39-3	150

Nitric Acid (94.5% by weight or greater)	7697-37-2	500
Nitric Oxide	10102-43-9	250
Nitroaniline (para Nitroaniline	100-01-6	5000
Nitromethane	75-52-5	2500
Nitrogen Dioxide	10102-44-0	250
Nitrogen Oxides (NO; NO(2); N2O4; N2O3)	10102-44-0	250
Nitrogen Tetroxide (also called Nitrogen Peroxide)	10544-72-6	250
Nitrogen Trifluoride	7783-54-2	5000
Nitrogen Trioxide	10544-73-7	250
Oleum (65% to 80% by weight; also called Fuming Sulfuric Acid)	8014-94-7	1000
Osmium Tetroxide	20816-12-0	100
Oxygen Difluoride (Fluorine Monoxide)	7783-41-7	100
Ozone	10028-15-6	100
Pentaborane	19624-22-7	100
Peracetic Acid (concentration greater 60% Acetic Acid; also called Peroxyacetic Acid)	79-21-0	1000
Perchloric Acid (concentration greater than 60% by weight)	7601-90-3	5000
Perchloromethyl Mercaptan	594-42-3	150
Perchloryl Fluoride	7616-94-6	5000
Peroxyacetic Acid (concentration greater than 60% Acetic Acid; also called Peracetic Acid)	79-21-0	1000
Phosgene (also called Carbonyl Chloride)	75-44-5	100
Phosphine (Hydrogen Phosphide)	7803-51-2	100
Phosphorus Oxychloride (also called Phosphoryl Chloride)	10025-87-3	1000
Phosphorus Trichloride	7719-12-2	1000
Phosphoryl Chloride (also called Phosphorus Oxychloride)	10025-87-3	1000
Propargyl Bromide	106-96-7	100
Propyl Nitrate	627-3-4	2500
Sarin	107-44-8	100
Selenium Hexafluoride	7783-79-1	1000

Stibine (Antimony Hydride)	7803-52-3	500
Sulfur Dioxide (liquid)	7446-09-5	1000
Sulfur Pentafluoride	5714-22-7	250
Sulfur Tetrafluoride	7783-60-0	250
Sulfur Trioxide (also called Sulfuric Anhydride)	7446-11-9	1000
Sulfuric Anhydride (also called Sulfur Trioxide)	7446-11-9	1000
Tellurium Hexafluoride	7783-80-4	250
Tetrafluoroethylene	116-14-3	5000
Tetrafluorohydrazine	10036-47-2	5000
Tetramethyl Lead	75-74-1	1000
Thionyl Chloride	7719-09-7	250
Trichloro (chloromethyl) Silane	1558-25-4	100
Trichloro (dichlorophenyl) Silane	27137-85-5	2500
Trichlorosilane	10025-78-2	5000
Trifluorochloroethylene	79-38-9	10000
Trimethyoxysilane	2487-90-3	1500

Codes for Tier II Reporting

Table I – Reporting Ranges

Range Value		Weight Range in Pounds	
		From...	To...
01		0	99
02		100	999
03		1,000	9,999
04		10,000	99,999
05		100,000	999,999
06		1,000,000	9,999,999
07		10,000,000	49,999,999
08		50,000,000	99,999,999
09		100,000,000	499,999,999
10		500,000,000	999,999,999
11		1 billion	higher than 1 billion

Key:

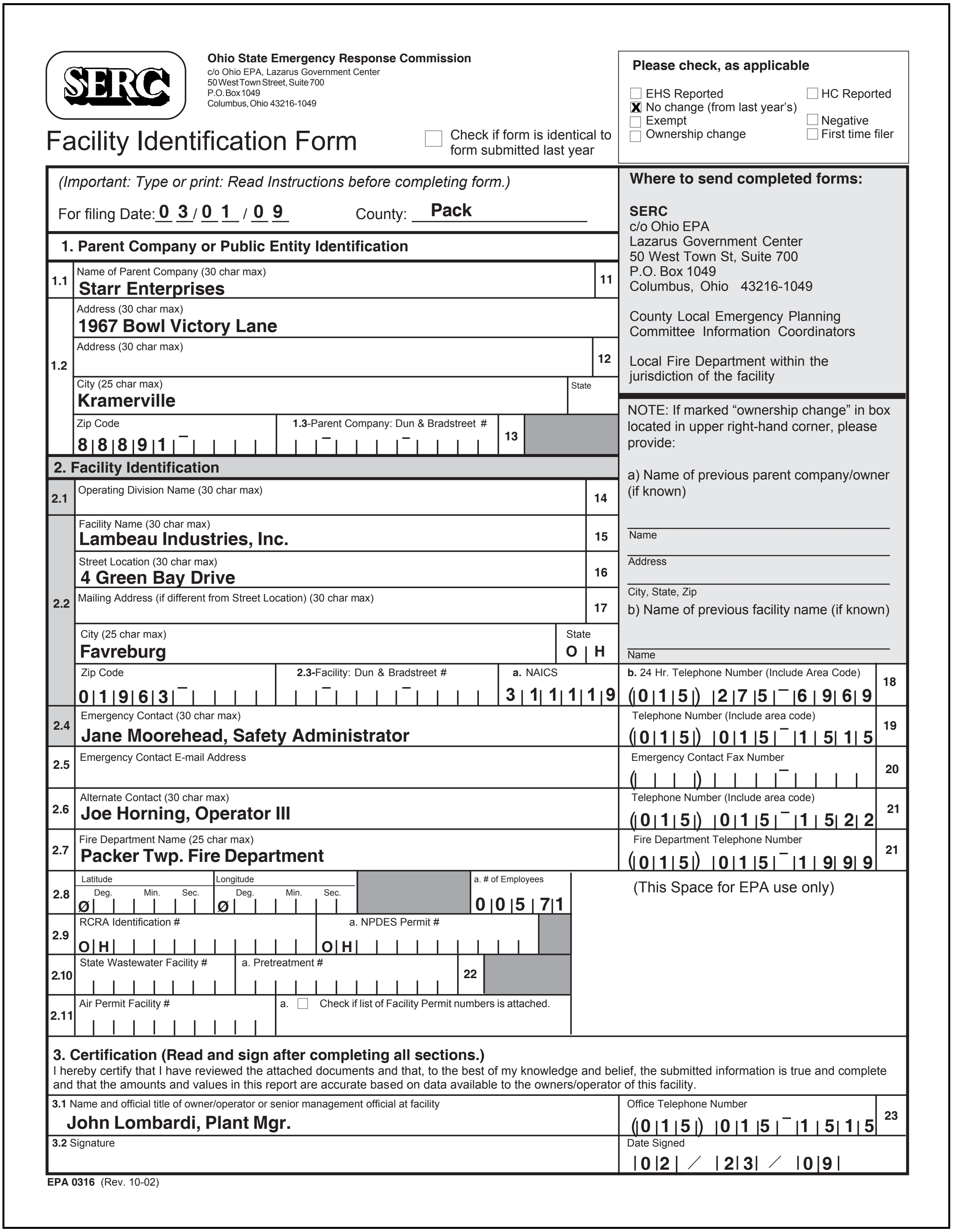
P – Pounds
G – Gallons
C – Range Code

Table II – Storage Types

Codes		Types of Storage
A		Above ground tank
B		Below ground tank
C		Tank inside building
D		Steel drum
E		Plastic or non-metallic drum
F		Can
G		Carboy
H		Silo
I		Fiber drum
J		Bag
K		Box
L		Cylinder
M		Glass bottles or jugs
N		Plastic bottles or jugs
O		Tote bin
P		Tank wagon
Q		Rail car
R		Other

Table III – Pressure and Temperature Conditions

Codes		Storage Conditions
		PRESSURE
1		Ambient pressure
2		Greater than ambient pressure
3		Less than ambient pressure
		TEMPERATURE
4		Ambient temperature
5		Greater than ambient temperature
6		Less than ambient temperature but not cryogenic
7		Cryogenic conditions



SERC

Ohio State Emergency Response Commission
c/o Ohio EPA, Lazarus Government Center
50 West Town Street, Suite 700
P.O. Box 1049
Columbus, Ohio 43216-1049

Facility Identification Form

☐ Check if form is identical to form submitted last year

Please check, as applicable

☐ EHS Reported	☐ HC Reported
☒ No change (from last year's)	
☐ Exempt	☐ Negative
☐ Ownership change	☐ First time filer

(Important: Type or print: Read Instructions before completing form.)

For filing Date: 03/01/09 County: Pack

Where to send completed forms:

SERC
c/o Ohio EPA
Lazarus Government Center
50 West Town St, Suite 700
P.O. Box 1049
Columbus, Ohio 43216-1049

County Local Emergency Planning Committee Information Coordinators

Local Fire Department within the jurisdiction of the facility

1. Parent Company or Public Entity Identification

1.1	Name of Parent Company (30 char max) **Starr Enterprises**	11
1.2	Address (30 char max) **1967 Bowl Victory Lane**	
	Address (30 char max)	12
	City (25 char max) **Kramerville**	State
	Zip Code **88891-**	1.3-Parent Company: Dun & Bradstreet # 13

2. Facility Identification

2.1	Operating Division Name (30 char max)	14
2.2	Facility Name (30 char max) **Lambeau Industries, Inc.**	15
	Street Location (30 char max) **4 Green Bay Drive**	16
	Mailing Address (if different from Street Location) (30 char max)	17
	City (25 char max) **Favreburg**	State **OH**
	Zip Code **01963-**	2.3-Facility: Dun & Bradstreet #
	a. NAICS **311119**	b. 24 Hr. Telephone Number (Include Area Code) **(015) 275-6969** 18
2.4	Emergency Contact (30 char max) **Jane Moorehead, Safety Administrator**	Telephone Number (Include area code) **(015) 015-1515** 19
2.5	Emergency Contact E-mail Address	Emergency Contact Fax Number ( ) - 20
2.6	Alternate Contact (30 char max) **Joe Horning, Operator III**	Telephone Number (Include area code) **(015) 015-1522** 21
2.7	Fire Department Name (25 char max) **Packer Twp. Fire Department**	Fire Department Telephone Number **(015) 015-1999** 21
2.8	Latitude Deg. Min. Sec. **0** Longitude Deg. Min. Sec. **0**	a. # of Employees **00571**
2.9	RCRA Identification # **OH**	a. NPDES Permit # **OH**
2.10	State Wastewater Facility #	a. Pretreatment # 22
2.11	Air Permit Facility #	a. ☐ Check if list of Facility Permit numbers is attached.

NOTE: If marked "ownership change" in box located in upper right-hand corner, please provide:

a) Name of previous parent company/owner (if known)

Name

Address

City, State, Zip

b) Name of previous facility name (if known)

Name

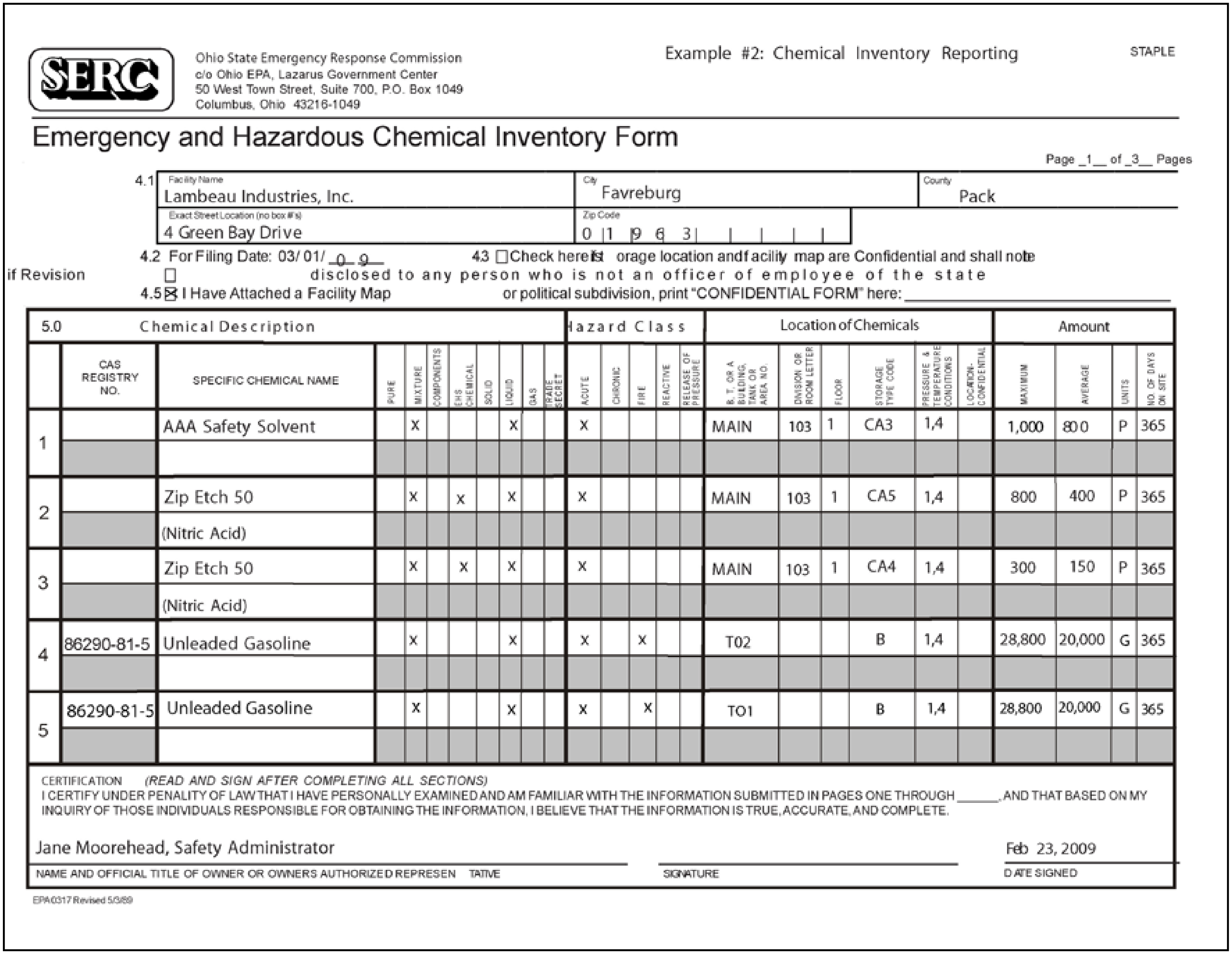
(This Space for EPA use only)

3. Certification (Read and sign after completing all sections.)

I hereby certify that I have reviewed the attached documents and that, to the best of my knowledge and belief, the submitted information is true and complete and that the amounts and values in this report are accurate based on data available to the owners/operator of this facility.

3.1 Name and official title of owner/operator or senior management official at facility **John Lombardi, Plant Mgr.**	Office Telephone Number **(015) 015-1515** 23
3.2 Signature	Date Signed **02/23/09**

EPA 0316 (Rev. 10-02)



Ohio State Emergency Response Commission
c/o Ohio EPA, Lazarus Government Center
50 West Town Street, Suite 700, P.O. Box 1049
Columbus, Ohio 43216-1049

Example #2: Chemical Inventory Reporting

STAPLE

Emergency and Hazardous Chemical Inventory Form

Page _1__ of _3__ Pages

4.1 Facility Name: Lambeau Industries, Inc.
City: Favreburg
County: Pack
Exact Street Location (no box #'s): 4 Green Bay Drive
Zip Code: 0 1 9 6 3

4.2 For Filing Date: 03/ 01/ _0 9_

if Revision ☐

43 ☐ Check here if storage location and facility map are Confidential and shall not be disclosed to any person who is not an officer of employee of the state or political subdivision, print "CONFIDENTIAL FORM" here: ____________

4.5 ☒ I Have Attached a Facility Map

5.0	Chemical Description										Hazard Class					Location of Chemicals						Amount			
	CAS REGISTRY NO.	SPECIFIC CHEMICAL NAME	PURE	MIXTURE	COMPONENTS	EHS CHEMICAL	SOLID	LIQUID	GAS	TRADE SECRET	ACUTE	CHRONIC	FIRE	REACTIVE	RELEASE OF PRESSURE	B.T. OR A BUILDING, TANK OR AREA NO.	DIVISION OR ROOM LETTER	FLOOR	STORAGE TYPE CODE	PRESSURE & TEMPERATURE CONDITIONS	LOCATION-CONFIDENTIAL	MAXIMUM	AVERAGE	UNITS	NO. OF DAYS ON SITE
1		AAA Safety Solvent		X				X			X					MAIN	103	1	CA3	1,4		1,000	800	P	365
2		Zip Etch 50		X		X		X			X					MAIN	103	1	CA5	1,4		800	400	P	365
		(Nitric Acid)																							
3		Zip Etch 50		X		X		X			X					MAIN	103	1	CA4	1,4		300	150	P	365
		(Nitric Acid)																							
4	86290-81-5	Unleaded Gasoline		X				X			X		X			T02			B	1,4		28,800	20,000	G	365
5	86290-81-5	Unleaded Gasoline		X				X			X		X			TO1			B	1,4		28,800	20,000	G	365

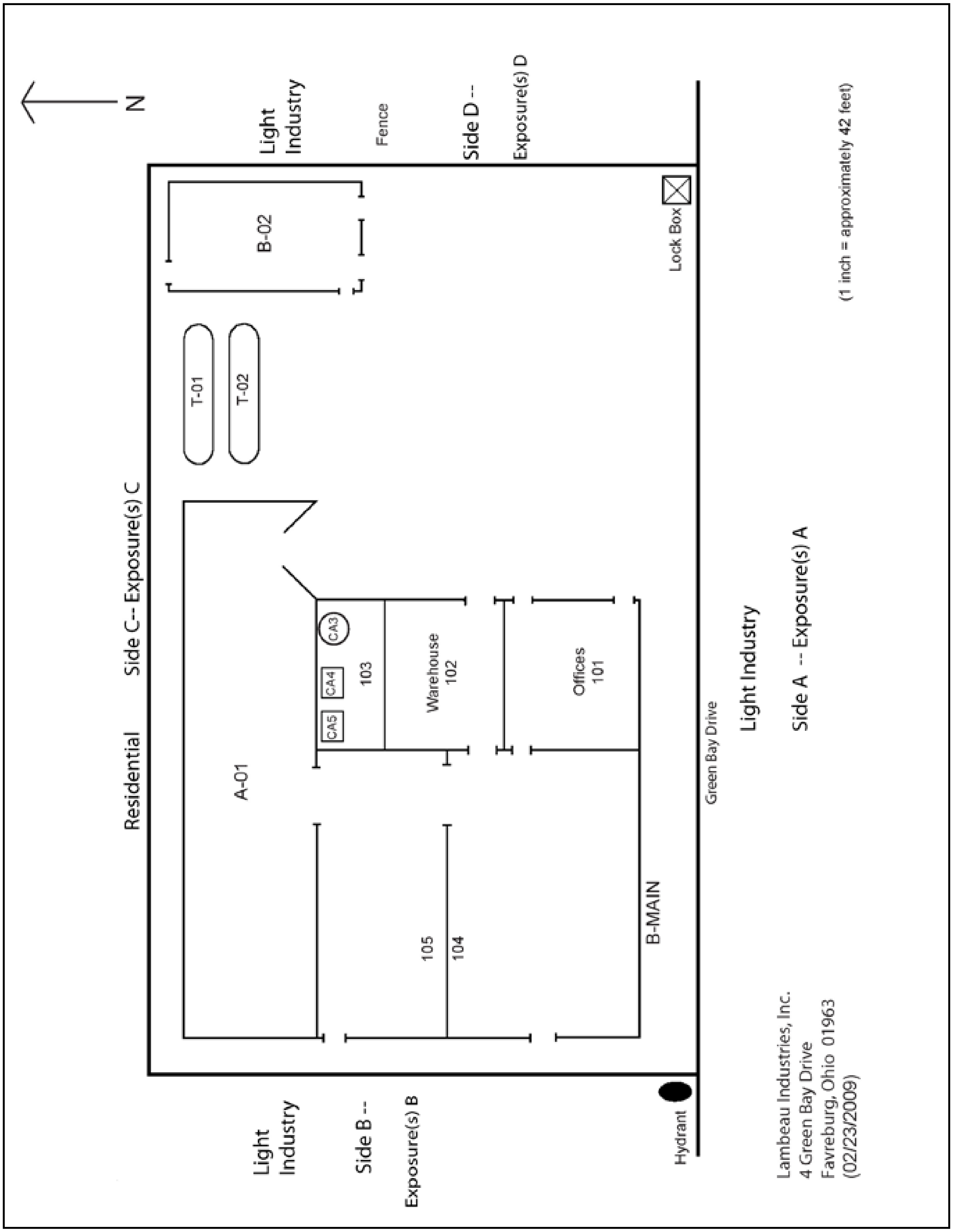
CERTIFICATION (READ AND SIGN AFTER COMPLETING ALL SECTIONS)
I CERTIFY UNDER PENALITY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED IN PAGES ONE THROUGH ______, AND THAT BASED ON MY INQUIRY OF THOSE INDIVIDUALS RESPONSIBLE FOR OBTAINING THE INFORMATION, I BELIEVE THAT THE INFORMATION IS TRUE, ACCURATE, AND COMPLETE.

Jane Moorehead, Safety Administrator
NAME AND OFFICIAL TITLE OF OWNER OR OWNERS AUTHORIZED REPRESENTATIVE

SIGNATURE

Feb 23, 2009
DATE SIGNED

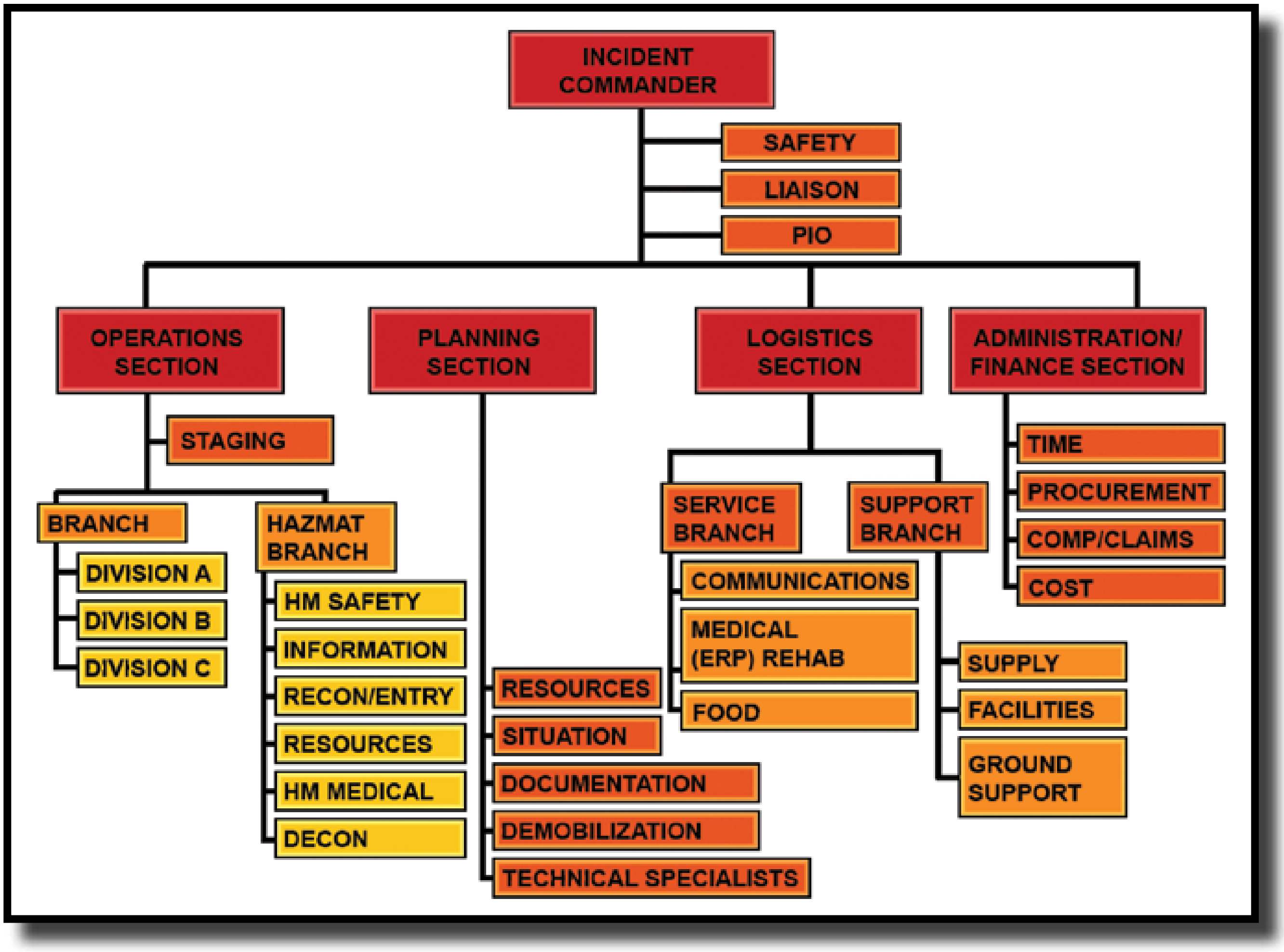
EPA0317 Revised 5/3/89



Lambeau Industries, Inc.
4 Green Bay Drive
Favreburg, Ohio 01963
(02/23/2009)

Module 2 – Risk-Based Response Actions

Incident Command System Organizational Structure



Excessive Temperature Injuries

Heat Injuries

All personnel should be monitored for heat stress whenever the humiture level or heat index exceeds 80°F; special precautions must be taken should the humiture level or heat index exceed 90°F. Emergency responders are subject to heat cramps, heat exhaustion and life-threatening heat stroke from excessive heat and fluid loss. A heat stress injury leaves a person predisposed to similar injuries in the future, making prevention a high priority goal.

- Heat Cramps: Minor cramping (primarily large muscle) caused by fluid and electrolyte loss. Treatment includes cooling and fluid/electrolyte replacement.
- Heat Exhaustion: Caused by fluid loss from sweating and other dehydrating conditions. The body experiences difficulty replacing the fluid loss, as exhibited by profuse sweating, cool skin, dizziness, loss of motor function, and sometimes loss of consciousness. Treatment includes cooling, fluid replacement and potentially, hospitalization.
- Heat Stroke: When suffering from this extreme heat emergency, the brain loses its ability to control the body’s temperature, so the body overheats from the inside out. Symptoms include hot skin that may be dry or wet if preceded by sweating; loss of motor control; and diminishing consciousness. This is a life-threatening medical condition and requires emergency medical attention, usually including rapid cooling and hospitalization.

Cold Injuries

Low temperatures combined with windy conditions create a danger of cold-induced injuries. Wind chill is an index of how the body perceives this combination of temperature and wind. Emergency response personnel are subject to three forms of cold injury, all of which are typically treated with gentle warming, supportive care and hospitalization.

- Frost Nip: Minor damage caused from the skin actually freezing. Signs include changes in skin color and a sensation of numbness.
- Frost Bite: Local cold injury in which the freezing causes deeper tissue damage. Signs include frozen skin that appears waxy.
- Hypothermia: Loss of body heat which results in a decrease in body temperature. Signs include shivering, loss of touch or sensation, stiff joints or rigid posturing, drowsiness or reduced consciousness, poor motor function, rapid pulse and slow breathing.

Dikes, Dams, Diversion and Retention Areas

Dikes are used to control releases on land, especially around a leaking container. Diking involves building a raised partition of soil, clay or a combination of materials around the spill.

Dams are barriers, usually built in ditches, streams or creeks that stop the downstream movement of released material. Diversion barriers channel spilled material into a containment area and require the same type of equipment and materials as diking.

Retention areas include holding pits and ponds used to catch and hold released material until it can be disposed. Digging retention areas may require the use of heavy equipment, which can introduce its own health/safety risk, over and above those posed by the incident.

Booms are composed of materials that float on top of the water, providing a barrier against the movement of floating insoluble materials. Booms are used to contain the released hazardous material.

There are two types of booms:

- *Absorbent Booms:* These booms collect the hazardous material release as it comes in contact with the boom.
- *Retaining Booms:* This type of boom contains a curtain or skirt that hangs under water to collect hazardous materials.

Filter fences are staked in flowing water within streams and rivers and use available sorbent (such as hay or wheat straw) to catch contaminated materials (given they are lighter than water).

Personal Protective Equipment (PPE)

Structural Fire Fighting Protective Clothing (SFPC)

Emergency response personnel need to use their SFPC routinely to protect themselves. Even though SFPC only offers limited protection against hazardous materials, it is usually the only protective clothing available to emergency response personnel initially. Refer to the current ERG 2008 (page 348) section on SFPC which describes the Incident Commander's responsibilities in ensuring fire fighters are protected. **Employees must be protected from the hazard encountered as stated in 29 CFR 1910.120(q)(3)(iii). This is the responsibility of the senior emergency response official.**

The outer SFPC shell can be constructed of Nomex, Kevlar, PBI or a combination of these substances. The addition of Kevlar and/or PBI reduces the overall weight of a garment, increases the amount of thermal heat it accepts before breaking down (escape time), and adds what the manufacturers refer to as "rip or tear strength" to the Nomex fabric.

SFPC is designed to provide personnel with limited thermal protection and protection from the toxic by-products of combustion. SFPC is not designed to withstand direct flame impingement (contact). It is only capable of providing thermal protection from heat and toxic smoke situations routinely encountered by fire fighters. Furthermore, SFPC is not designed to provide adequate protection from harmful vapors and liquids that can be produced during hazardous materials incidents. No layers or components of SFPC are designed to protect against chemicals.

Decontamination Guidelines

The first and most important guideline for emergency response personnel during operations at a hazardous materials incident is to remember not to get contaminated. If possible, approach the area from uphill and upwind. Avoid walking through vapor clouds, spraying product or puddles of liquid product. Also keep in mind:

- Time
    - Don’t spend any more time in the hazardous area to perform the task than necessary.
- Distance
    - Use binoculars to identify product and situation if possible.
    - Don’t get any closer than necessary to the product to achieve the objective.
- Shielding
    - As noted, SFPC and SCBA may not fully protect the emergency response personnel and should only be used for life-saving measures after performing a risk-benefit analysis.

Generally speaking, outer, more heavily contaminated items (e.g., outer boots, gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (e.g., jackets, pants). If proper procedures are utilized, the main areas of contamination should be the hands and feet.

All equipment used for decontamination must also be decontaminated and/or disposed of properly. Most teams will leave the decontamination area set up after the operation is complete. It then is disposed of by the cleanup contractor.

Some items can’t be decontaminated; some are disposable. Buckets, brushes, clothing, tools and other contaminated equipment should be collected, placed in containers and labeled. During emergency decon, contaminated runoff is of less concern. However, it still should be contained as much as possible. Protect storm drains, sanitary sewers, etc. from product entry.

After the incident is stabilized, this should be the responsibility of the cleanup contractor to collect and dispose of spent solutions and wash water as soon as practical.

Decontamination guidelines include:

- Deck guns, ladder pipes or unmanned 2½ inch fog nozzles, set on a wide fog pattern at low nozzle pressure, should be used to provide a large amount of water for emergency decon of groups.
- Visible, dry contaminants should be removed with a brush, rags or gauze.
- Removal of clothing, in many cases, will reduce a large portion of contaminants from coming into contact with the body; however, privacy must be insured.
- In some instances, it might be most appropriate to remove clothing before — rather than after — flushing. The extent and type of contaminant determines the proper sequence for decontamination steps.
- To further guard against secondary contamination, clothing that has been contaminated and undergone emergency decontamination should be placed in plastic bags for further decontamination and/or disposal at a later time.
- Affected skin and mucous membranes (including the eyes) should be flushed with copious amounts of water.
- When multiple areas of the body are affected, priority should be given to particularly vulnerable areas, such as the eyes.
- Large amounts of water must be used when corrosives are involved.
- Start at the top, have victims remain standing yet bent over for hair washing; then proceed downward.
- It is also for protective purposes that a decontamination staging area must be located some distance away from the scene – away from potential exposure – as soon as possible.
- No one, (including EMS transport patients) should be allowed to leave a scene that is suspected of being contaminated, until they are decontaminated.
- The patient area of the EMS transport vehicle must be protected when transporting victims to a medical facility.
- Only keep items necessary for patient care in the vehicle.
- An operational ventilation system protects the patient, as well as protection for EMS providers.
- EMS providers may need to use chemical protective clothing (CPC) such as Tyvek coveralls, latex gloves and air-purifying respirators (APR).
- The medical treatment facility that will be receiving the transported patient needs to be advised as soon as possible, so they can take the appropriate precautions prior to their arrival.

Module 3 – Case Studies

ALLYL ALCOHOL

0095
April 2000

CAS No: 107-18-6
RTECS No: BA5075000
UN No: 1098
EC No: 603-015-00-6

Vinyl carbinol
Propenyl alcohol
2-Propen-1-ol
3-Hydroxypropene
C_3H_6O / $CH_2=CHCH_2OH$
Molecular mass: 58.1

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Flammable.	NO open flames, NO sparks, and NO smoking.	Powder, alcohol-resistant foam, water in large amounts, carbon dioxide.
EXPLOSION	Above 21•C explosive vapour/air mixtures may be formed.	Above 21•C use a closed system, ventilation, and explosion-proof electrical equipment.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		**STRICT HYGIENE! PREVENT GENERATION OF MISTS!**	
Inhalation	Headache. Nausea. Vomiting.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest.
Skin	MAY BE ABSORBED! Aching. Pain. Blisters.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
Eyes	Redness. Pain. Blurred vision. Temporary loss of vision. Severe deep burns. Sensitivity to light.	Face shield or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Abdominal pain. Unconsciousness.	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Give plenty of water to drink. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Rest. Refer for medical attention.

SPILLAGE DISPOSAL	PACKAGING & LABELLING	
Remove all ignition sources. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Personal protection: complete protective clothing including self-contained breathing apparatus. Do NOT let this chemical enter the environment.	T Symbol N Symbol R: 10-23/24/25-36/37/38-50 S: (1/2-)36/37/39-38-45-61 UN Hazard Class: 6.1 UN Subsidiary Risks: 3 UN Pack Group: I	Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs.

EMERGENCY RESPONSE	SAFE STORAGE
Transport Emergency Card: TEC (R)-61S1098 NFPA Code: H3; F3; R0	Fireproof. Separated from strong oxidants, food and feedstuffs.

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SEE IMPORTANT INFORMATION ON THE BACK.

ALLYL ALCOHOL

0095
April 2000

CAS No: 107-18-6 RTECS No: BA5075000 UN No: 1098 EC No: 603-015-00-6	Vinyl carbinol Propenyl alcohol 2-Propen-1-ol 3-Hydroxypropene C_3H_6O / $CH_2{=}CHCH_2OH$ Molecular mass: 58.1

TYPES OF HAZARD/ EXPOSURE	**ACUTE HAZARDS/SYMPTOMS**	**PREVENTION**	**FIRST AID/FIRE FIGHTING**
FIRE	Flammable.	NO open flames, NO sparks, and NO smoking.	Powder, alcohol-resistant foam, water in large amounts, carbon dioxide.
EXPLOSION	Above 21•C explosive vapour/air mixtures may be formed.	Above 21•C use a closed system, ventilation, and explosion-proof electrical equipment.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		**STRICT HYGIENE! PREVENT GENERATION OF MISTS!**	
Inhalation	Headache. Nausea. Vomiting.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest.
Skin	MAY BE ABSORBED! Aching. Pain. Blisters.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
Eyes	Redness. Pain. Blurred vision. Temporary loss of vision. Severe deep burns. Sensitivity to light.	Face shield or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Abdominal pain. Unconsciousness.	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Give plenty of water to drink. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Rest. Refer for medical attention.

SPILLAGE DISPOSAL	**PACKAGING & LABELLING**	
Remove all ignition sources. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Personal protection: complete protective clothing including self-contained breathing apparatus. Do NOT let this chemical enter the environment.	T Symbol N Symbol R: 10-23/24/25-36/37/38-50 S: (1/2-)36/37/39-38-45-61 UN Hazard Class: 6.1 UN Subsidiary Risks: 3 UN Pack Group: I	Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs.

EMERGENCY RESPONSE	**SAFE STORAGE**
Transport Emergency Card: TEC (R)-61S1098 NFPA Code: H3; F3; R0	Fireproof. Separated from strong oxidants, food and feedstuffs.

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UNEP

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0095 ALLYL ALCOHOL

IMPORTANT DATA

Physical State; Appearance
COLOURLESS LIQUID, WITH PUNGENT ODOUR.

Chemical dangers
Reacts with carbon tetrachloride, nitric acid, chlorosulphonic acid causing fire and explosion hazard.

Occupational exposure limits
TLV: 0.5 ppm as TWA; (skin); A4 (not classifiable as a human carcinogen); (ACGIH 2004).
MAK: skin absorption (H); Carcinogen category: 3B; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation of its vapour, through the skin and by ingestion.

Inhalation risk
A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20°C

Effects of short-term exposure
Lachrymation. The substance is irritating to the eyes, the skin and the respiratory tract. The substance may cause effects on the muscles, resulting in local spasm and aching. The effects may be delayed. The substance may cause effects on the kidneys and liver.

PHYSICAL PROPERTIES

Boiling point: 97°C
Melting point: -129°C
Relative density (water = 1): 0.9
Solubility in water: miscible
Vapour pressure, kPa at 20°C: 2.5
Relative vapour density (air = 1): 2.0
Relative density of the vapour/air-mixture at 20°C(air = 1): 1.03
Flash point: 21°C c.c.
Auto-ignition temperature: 378°C
Explosive limits, vol% in air: 2.5-18.0
Octanol/water partition coefficient as log Pow: 0.17

ENVIRONMENTAL DATA

The substance is very toxic to aquatic organisms.

NOTES

Depending on the degree of exposure, periodic medical examination is suggested.
The odour warning when the exposure limit value is exceeded is insufficient.
Card has been partly updated in April 2005. See section Occupational Exposure Limits.

ADDITIONAL INFORMATION

ALLYL CHLORIDE

0010
October 2004

CAS No: 107-05-1
RTECS No: UC7350000
UN No: 1100
EC No: 602-029-00-X

3-Chloro-1-propene
3-Chloropropylene
Chloroallylene
C_3H_5Cl / $CH_2=CHCH_2Cl$
Molecular mass: 76.5

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Highly flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Powder, AFFF, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive. Risk of fire and explosion on contact with incompatible materials: see Chemical Dangers.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Do NOT use compressed air for filling, discharging, or handling.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		**STRICT HYGIENE!**	**IN ALL CASES CONSULT A DOCTOR!**
Inhalation	Cough. Sore throat. Headache. Dizziness. Weakness. Laboured breathing. Vomiting. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
Skin	Redness. Burning sensation. Pain.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Refer for medical attention.
Eyes	Redness. Pain. Blurred vision.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Abdominal pain. Burning sensation. Vomiting.	Do not eat, drink, or smoke during work.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Give plenty of water to drink. Refer for medical attention.

SPILLAGE DISPOSAL

Evacuate danger area! Consult an expert! Collect leaking liquid in covered containers. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer. Personal protection: complete protective clothing including self-contained breathing apparatus.

PACKAGING & LABELLING

F Symbol
Xn Symbol
N Symbol
R: 11-20/21/22-36/37/38-40-48/20-68-50
S: (2-)16-25-26-36/37-46-61
Note: D
UN Hazard Class: 3
UN Subsidiary Risks: 6.1
UN Pack Group: I

Airtight. Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs.

EMERGENCY RESPONSE

Transport Emergency Card: TEC (R)-30S1100
NFPA Code: H3; F3; R1

SAFE STORAGE

Fireproof. Separated from food and feedstuffs, incompatible materials. See Chemical Dangers. Dry.

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SEE IMPORTANT INFORMATION ON THE BACK.

0010 ALLYL CHLORIDE

IMPORTANT DATA

Physical State; Appearance
COLOURLESS LIQUID, WITH PUNGENT ODOUR.

Physical dangers
The vapour is heavier than air and may travel along the ground; distant ignition possible.

Chemical dangers
The substance will polymerize under the influence of acid(s) heat and peroxides with fire or explosion hazard. On combustion, forms toxic and corrosive fumes hydrogen chloride (see ICSC0163). Reacts violently with strong oxidants and powdered metals causing fire and explosion hazard. Reacts with water to produce hydrochloric acid. Attacks plastic, rubber and coatings.

Occupational exposure limits
TLV: 1 ppm as TWA; 2 ppm as STEL; (skin); A3; (ACGIH 2004).
MAK: H; Carcinogen category: 3B; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation and through the skin and by ingestion.

Inhalation risk
A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20°C.

Effects of short-term exposure
The substance irritates the eyes, the skin and the respiratory tract. The substance may cause effects on the central nervous system. Inhalation of the vapour at high concentrations may cause lung oedema (see Notes). The effects may be delayed.

Effects of long-term or repeated exposure
The substance may have effects on the peripheral nervous system, cardiovascular system, kidneys, liver, resulting in kidney impairment, liver impairment.

PHYSICAL PROPERTIES

Boiling point: 45°C
Melting point: -135°C
Relative density (water = 1): 0.94
Solubility in water, g/100 ml at 20°C: 0.36
Vapour pressure, kPa at 20°C: 39.3
Relative vapour density (air = 1): 2.6
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.6
Flash point: -32°C c.c.
Auto-ignition temperature: 390°C
Explosive limits, vol% in air: 2.9-11.2
Octanol/water partition coefficient as log Pow: 2.1

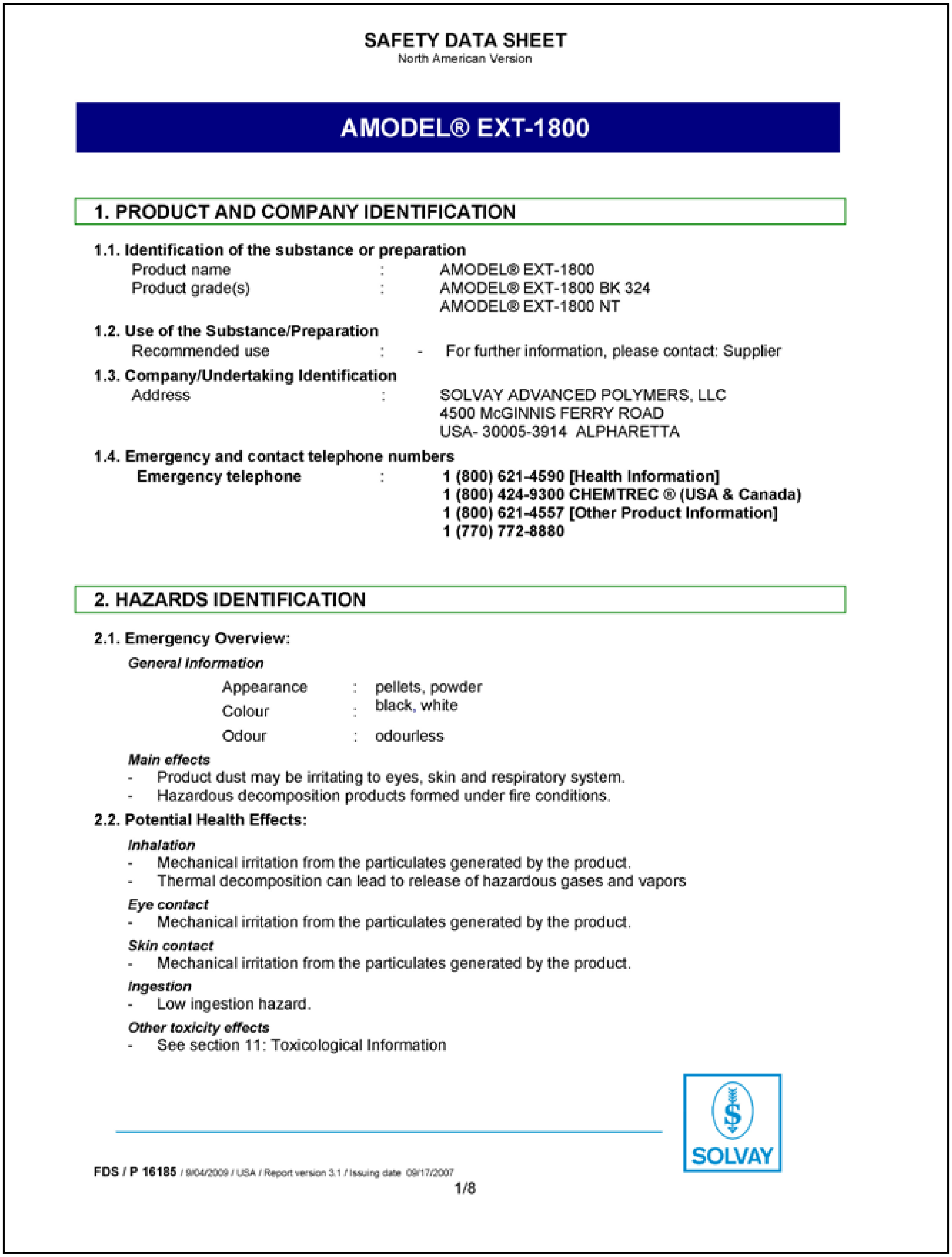
ENVIRONMENTAL DATA

The substance is harmful to aquatic organisms.

NOTES

Depending on the degree of exposure, periodic medical examination is suggested.
The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential.
Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered.

ADDITIONAL INFORMATION



SAFETY DATA SHEET

North American Version

AMODEL® EXT-1800

1. PRODUCT AND COMPANY IDENTIFICATION

1.1. Identification of the substance or preparation

Product name : AMODEL® EXT-1800
Product grade(s) : AMODEL® EXT-1800 BK 324
AMODEL® EXT-1800 NT

1.2. Use of the Substance/Preparation

Recommended use : - For further information, please contact: Supplier

1.3. Company/Undertaking Identification

Address : SOLVAY ADVANCED POLYMERS, LLC
4500 McGINNIS FERRY ROAD
USA- 30005-3914 ALPHARETTA

1.4. Emergency and contact telephone numbers

Emergency telephone : **1 (800) 621-4590 [Health Information]**
1 (800) 424-9300 CHEMTREC ® (USA & Canada)
1 (800) 621-4557 [Other Product Information]
1 (770) 772-8880

2. HAZARDS IDENTIFICATION

2.1. Emergency Overview:

General Information

Appearance : pellets, powder
Colour : black, white
Odour : odourless

Main effects

- Product dust may be irritating to eyes, skin and respiratory system.
- Hazardous decomposition products formed under fire conditions.

2.2. Potential Health Effects:

Inhalation

- Mechanical irritation from the particulates generated by the product.
- Thermal decomposition can lead to release of hazardous gases and vapors

Eye contact

- Mechanical irritation from the particulates generated by the product.

Skin contact

- Mechanical irritation from the particulates generated by the product.

Ingestion

- Low ingestion hazard.

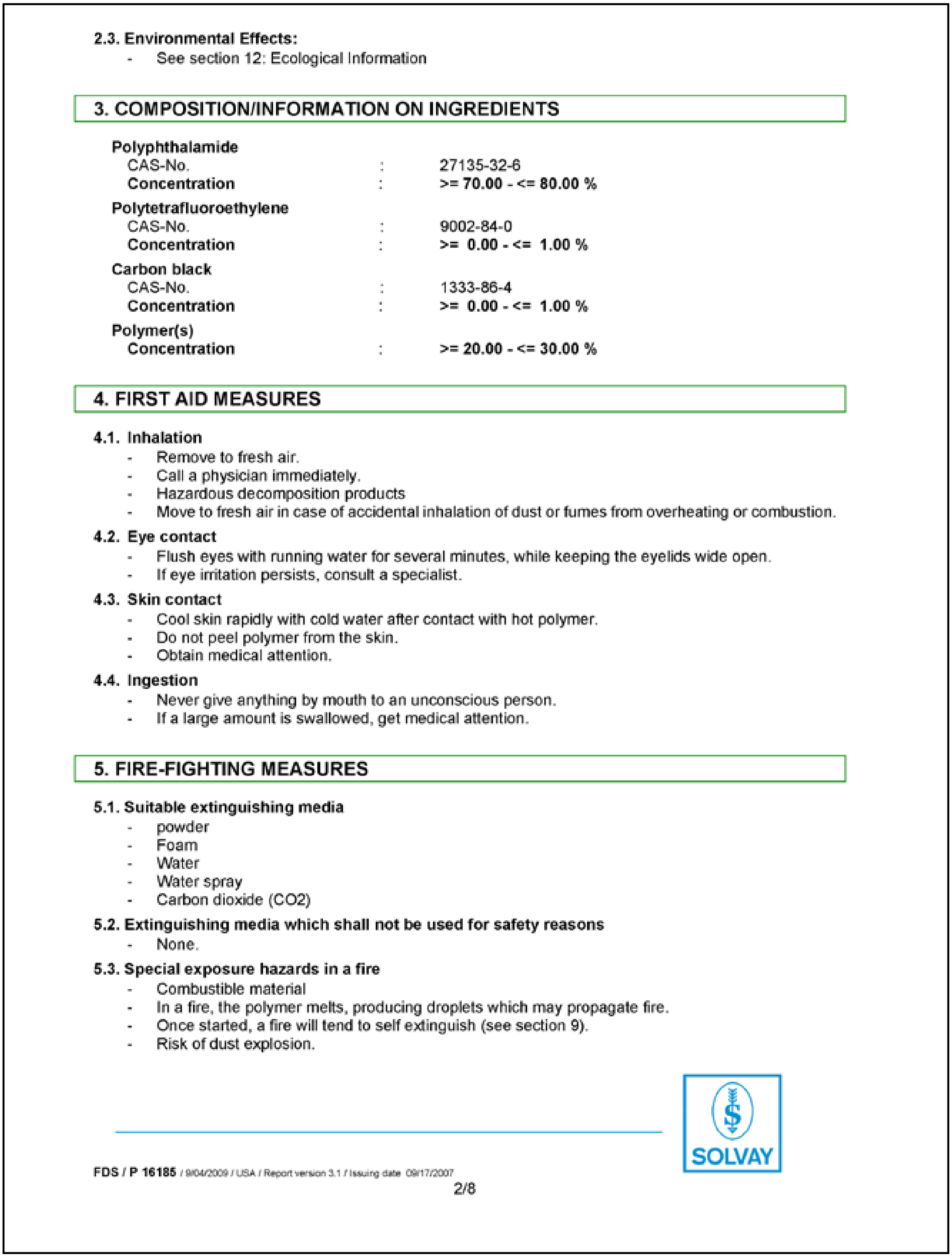
Other toxicity effects

- See section 11: Toxicological Information

SOLVAY

FDS / P 16185 / 9/04/2009 / USA / Report version 3.1 / Issuing date 09/17/2007

1/8



2.3. Environmental Effects:

- See section 12: Ecological Information

3. COMPOSITION/INFORMATION ON INGREDIENTS

Polyphthalamide
CAS-No. : 27135-32-6
Concentration : >= 70.00 - <= 80.00 %

Polytetrafluoroethylene
CAS-No. : 9002-84-0
Concentration : >= 0.00 - <= 1.00 %

Carbon black
CAS-No. : 1333-86-4
Concentration : >= 0.00 - <= 1.00 %

Polymer(s)
Concentration : >= 20.00 - <= 30.00 %

4. FIRST AID MEASURES

4.1. Inhalation

- Remove to fresh air.
- Call a physician immediately.
- Hazardous decomposition products
- Move to fresh air in case of accidental inhalation of dust or fumes from overheating or combustion.

4.2. Eye contact

- Flush eyes with running water for several minutes, while keeping the eyelids wide open.
- If eye irritation persists, consult a specialist.

4.3. Skin contact

- Cool skin rapidly with cold water after contact with hot polymer.
- Do not peel polymer from the skin.
- Obtain medical attention.

4.4. Ingestion

- Never give anything by mouth to an unconscious person.
- If a large amount is swallowed, get medical attention.

5. FIRE-FIGHTING MEASURES

5.1. Suitable extinguishing media

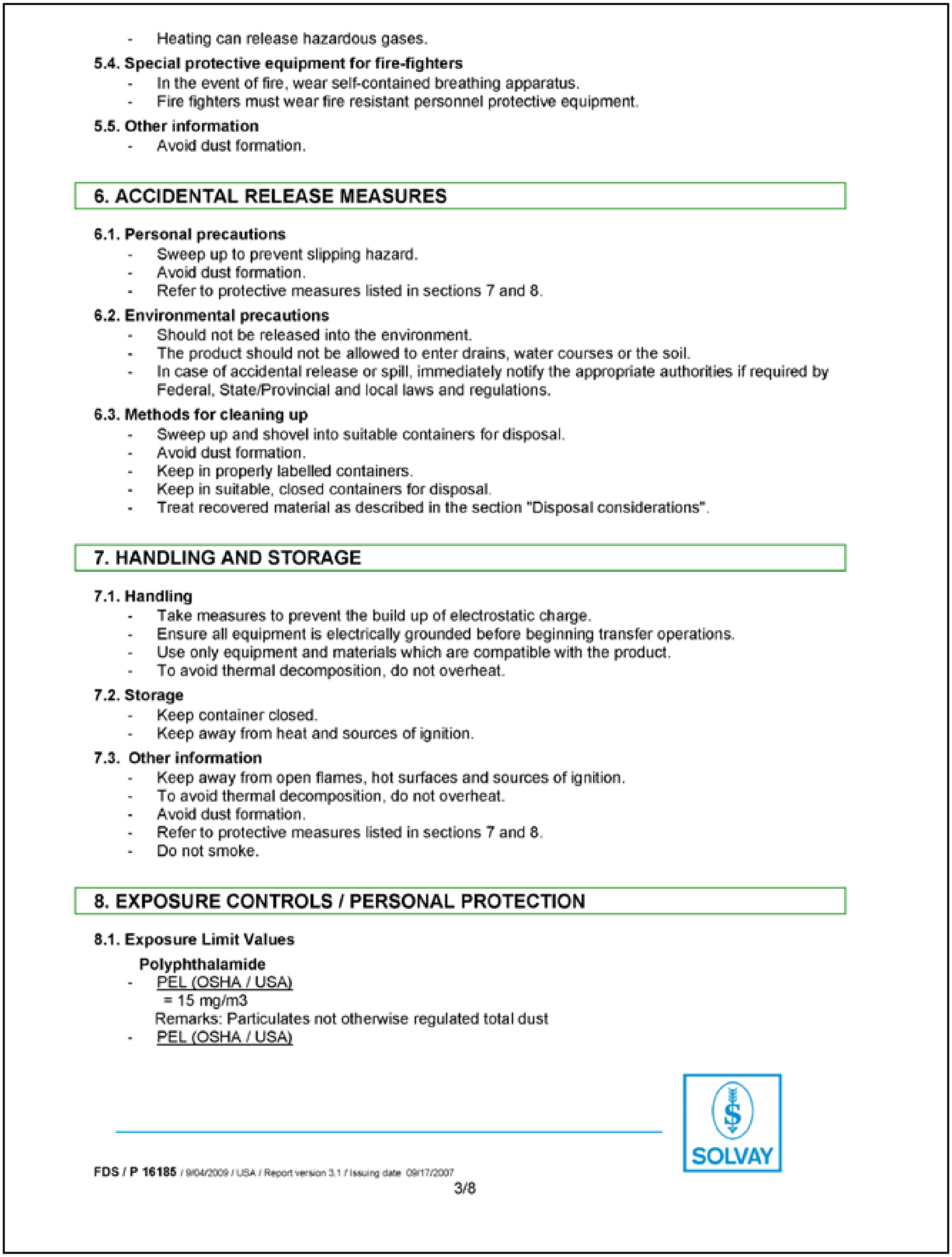
- powder
- Foam
- Water
- Water spray
- Carbon dioxide (CO2)

5.2. Extinguishing media which shall not be used for safety reasons

- None.

5.3. Special exposure hazards in a fire

- Combustible material
- In a fire, the polymer melts, producing droplets which may propagate fire.
- Once started, a fire will tend to self extinguish (see section 9).
- Risk of dust explosion.



- Heating can release hazardous gases.

5.4. Special protective equipment for fire-fighters

- In the event of fire, wear self-contained breathing apparatus.
- Fire fighters must wear fire resistant personnel protective equipment.

5.5. Other information

- Avoid dust formation.

6. ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions

- Sweep up to prevent slipping hazard.
- Avoid dust formation.
- Refer to protective measures listed in sections 7 and 8.

6.2. Environmental precautions

- Should not be released into the environment.
- The product should not be allowed to enter drains, water courses or the soil.
- In case of accidental release or spill, immediately notify the appropriate authorities if required by Federal, State/Provincial and local laws and regulations.

6.3. Methods for cleaning up

- Sweep up and shovel into suitable containers for disposal.
- Avoid dust formation.
- Keep in properly labelled containers.
- Keep in suitable, closed containers for disposal.
- Treat recovered material as described in the section "Disposal considerations".

7. HANDLING AND STORAGE

7.1. Handling

- Take measures to prevent the build up of electrostatic charge.
- Ensure all equipment is electrically grounded before beginning transfer operations.
- Use only equipment and materials which are compatible with the product.
- To avoid thermal decomposition, do not overheat.

7.2. Storage

- Keep container closed.
- Keep away from heat and sources of ignition.

7.3. Other information

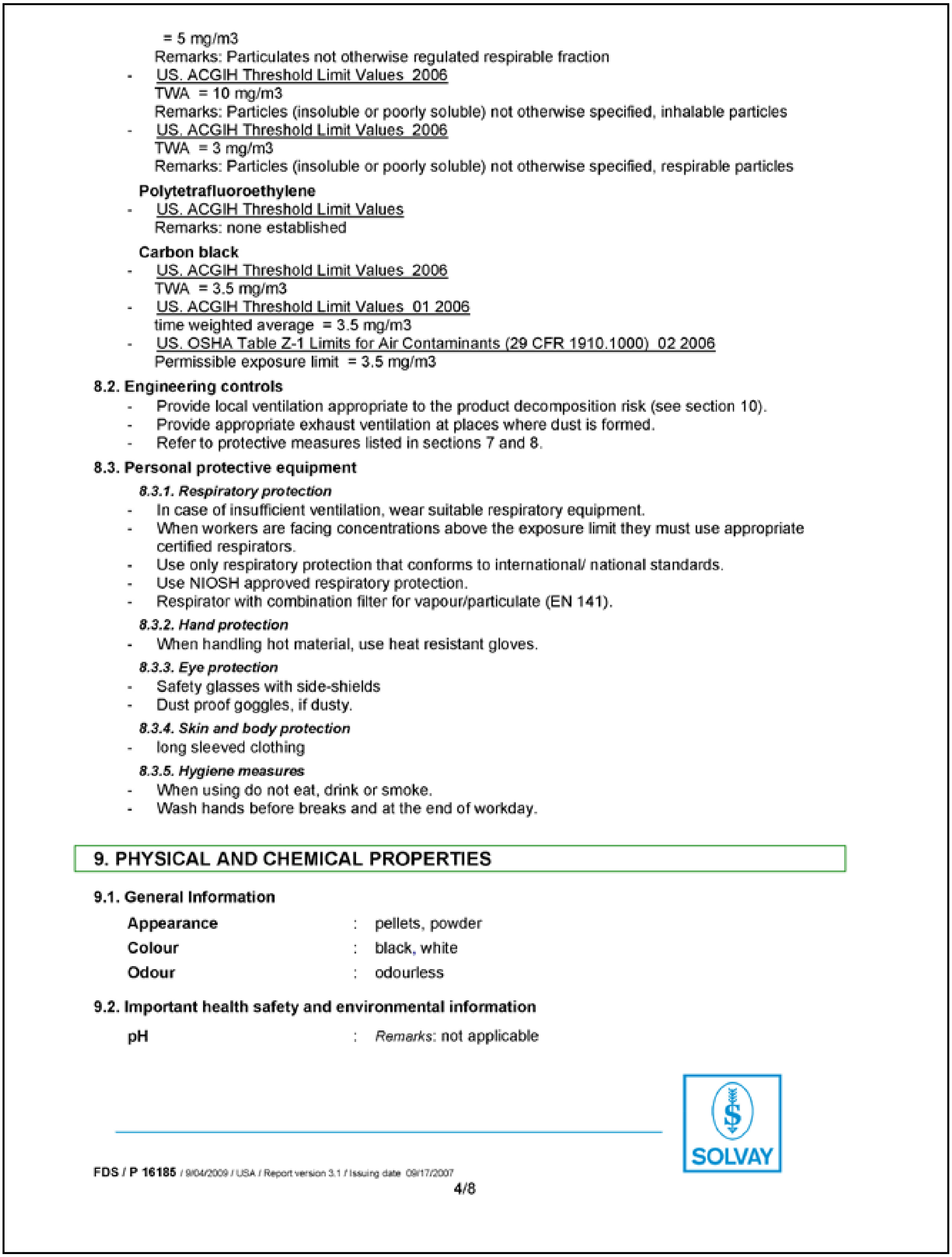
- Keep away from open flames, hot surfaces and sources of ignition.
- To avoid thermal decomposition, do not overheat.
- Avoid dust formation.
- Refer to protective measures listed in sections 7 and 8.
- Do not smoke.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1. Exposure Limit Values

Polyphthalamide

- <u>PEL (OSHA / USA)</u>
  = 15 mg/m3
  Remarks: Particulates not otherwise regulated total dust
- <u>PEL (OSHA / USA)</u>



= 5 mg/m3
Remarks: Particulates not otherwise regulated respirable fraction

- US. ACGIH Threshold Limit Values 2006
  TWA = 10 mg/m3
  Remarks: Particles (insoluble or poorly soluble) not otherwise specified, inhalable particles
- US. ACGIH Threshold Limit Values 2006
  TWA = 3 mg/m3
  Remarks: Particles (insoluble or poorly soluble) not otherwise specified, respirable particles

Polytetrafluoroethylene

- US. ACGIH Threshold Limit Values
  Remarks: none established

Carbon black

- US. ACGIH Threshold Limit Values 2006
  TWA = 3.5 mg/m3
- US. ACGIH Threshold Limit Values 01 2006
  time weighted average = 3.5 mg/m3
- US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) 02 2006
  Permissible exposure limit = 3.5 mg/m3

8.2. Engineering controls

- Provide local ventilation appropriate to the product decomposition risk (see section 10).
- Provide appropriate exhaust ventilation at places where dust is formed.
- Refer to protective measures listed in sections 7 and 8.

8.3. Personal protective equipment

8.3.1. Respiratory protection

- In case of insufficient ventilation, wear suitable respiratory equipment.
- When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.
- Use only respiratory protection that conforms to international/ national standards.
- Use NIOSH approved respiratory protection.
- Respirator with combination filter for vapour/particulate (EN 141).

8.3.2. Hand protection

- When handling hot material, use heat resistant gloves.

8.3.3. Eye protection

- Safety glasses with side-shields
- Dust proof goggles, if dusty.

8.3.4. Skin and body protection

- long sleeved clothing

8.3.5. Hygiene measures

- When using do not eat, drink or smoke.
- Wash hands before breaks and at the end of workday.

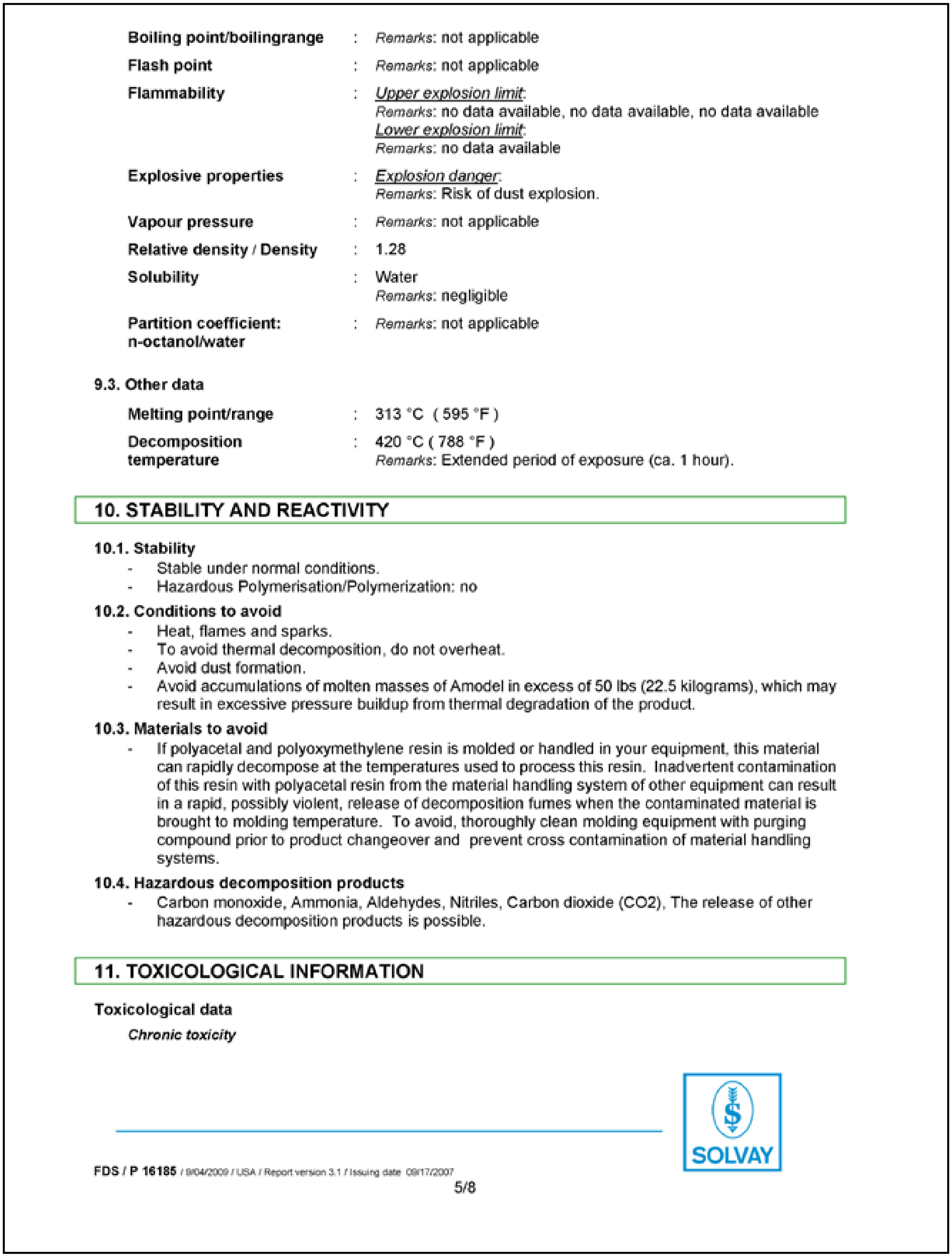
9. PHYSICAL AND CHEMICAL PROPERTIES

9.1. General Information

Appearance	:	pellets, powder
Colour	:	black, white
Odour	:	odourless

9.2. Important health safety and environmental information

pH	:	*Remarks:* not applicable



Boiling point/boilingrange : *Remarks*: not applicable

Flash point : *Remarks*: not applicable

Flammability : *Upper explosion limit*:
Remarks: no data available, no data available, no data available
Lower explosion limit:
Remarks: no data available

Explosive properties : *Explosion danger*:
Remarks: Risk of dust explosion.

Vapour pressure : *Remarks*: not applicable

Relative density / Density : 1.28

Solubility : Water
Remarks: negligible

Partition coefficient: n-octanol/water : *Remarks*: not applicable

9.3. Other data

Melting point/range : 313 °C (595 °F)

Decomposition temperature : 420 °C (788 °F)
Remarks: Extended period of exposure (ca. 1 hour).

10. STABILITY AND REACTIVITY

10.1. Stability

- Stable under normal conditions.
- Hazardous Polymerisation/Polymerization: no

10.2. Conditions to avoid

- Heat, flames and sparks.
- To avoid thermal decomposition, do not overheat.
- Avoid dust formation.
- Avoid accumulations of molten masses of Amodel in excess of 50 lbs (22.5 kilograms), which may result in excessive pressure buildup from thermal degradation of the product.

10.3. Materials to avoid

- If polyacetal and polyoxymethylene resin is molded or handled in your equipment, this material can rapidly decompose at the temperatures used to process this resin. Inadvertent contamination of this resin with polyacetal resin from the material handling system of other equipment can result in a rapid, possibly violent, release of decomposition fumes when the contaminated material is brought to molding temperature. To avoid, thoroughly clean molding equipment with purging compound prior to product changeover and prevent cross contamination of material handling systems.

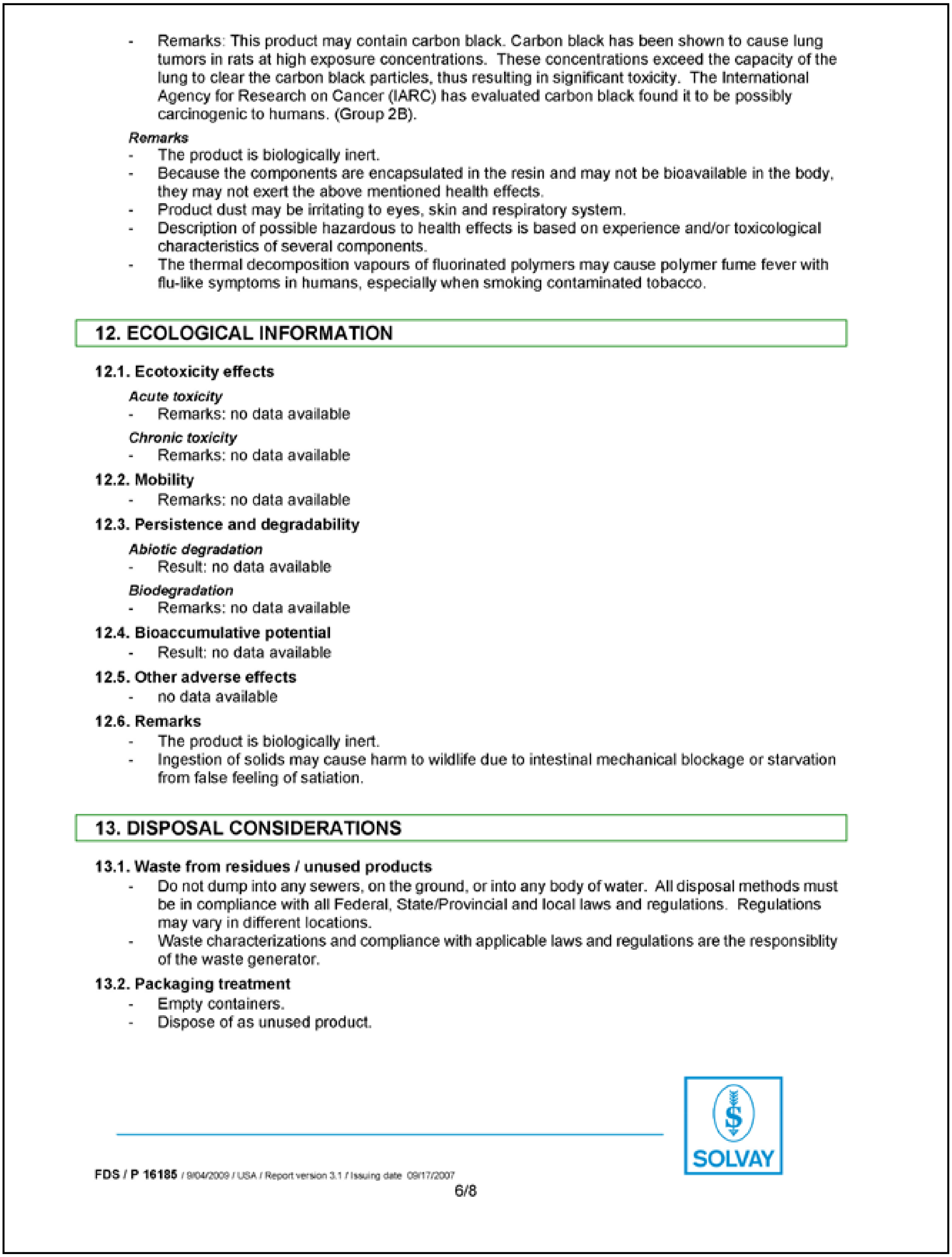
10.4. Hazardous decomposition products

- Carbon monoxide, Ammonia, Aldehydes, Nitriles, Carbon dioxide (CO2), The release of other hazardous decomposition products is possible.

11. TOXICOLOGICAL INFORMATION

Toxicological data

Chronic toxicity



- Remarks: This product may contain carbon black. Carbon black has been shown to cause lung tumors in rats at high exposure concentrations. These concentrations exceed the capacity of the lung to clear the carbon black particles, thus resulting in significant toxicity. The International Agency for Research on Cancer (IARC) has evaluated carbon black found it to be possibly carcinogenic to humans. (Group 2B).

Remarks

- The product is biologically inert.
- Because the components are encapsulated in the resin and may not be bioavailable in the body, they may not exert the above mentioned health effects.
- Product dust may be irritating to eyes, skin and respiratory system.
- Description of possible hazardous to health effects is based on experience and/or toxicological characteristics of several components.
- The thermal decomposition vapours of fluorinated polymers may cause polymer fume fever with flu-like symptoms in humans, especially when smoking contaminated tobacco.

12. ECOLOGICAL INFORMATION

12.1. Ecotoxicity effects

Acute toxicity

- Remarks: no data available

Chronic toxicity

- Remarks: no data available

12.2. Mobility

- Remarks: no data available

12.3. Persistence and degradability

Abiotic degradation

- Result: no data available

Biodegradation

- Remarks: no data available

12.4. Bioaccumulative potential

- Result: no data available

12.5. Other adverse effects

- no data available

12.6. Remarks

- The product is biologically inert.
- Ingestion of solids may cause harm to wildlife due to intestinal mechanical blockage or starvation from false feeling of satiation.

13. DISPOSAL CONSIDERATIONS

13.1. Waste from residues / unused products

- Do not dump into any sewers, on the ground, or into any body of water. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations.
- Waste characterizations and compliance with applicable laws and regulations are the responsiblity of the waste generator.

13.2. Packaging treatment

- Empty containers.
- Dispose of as unused product.

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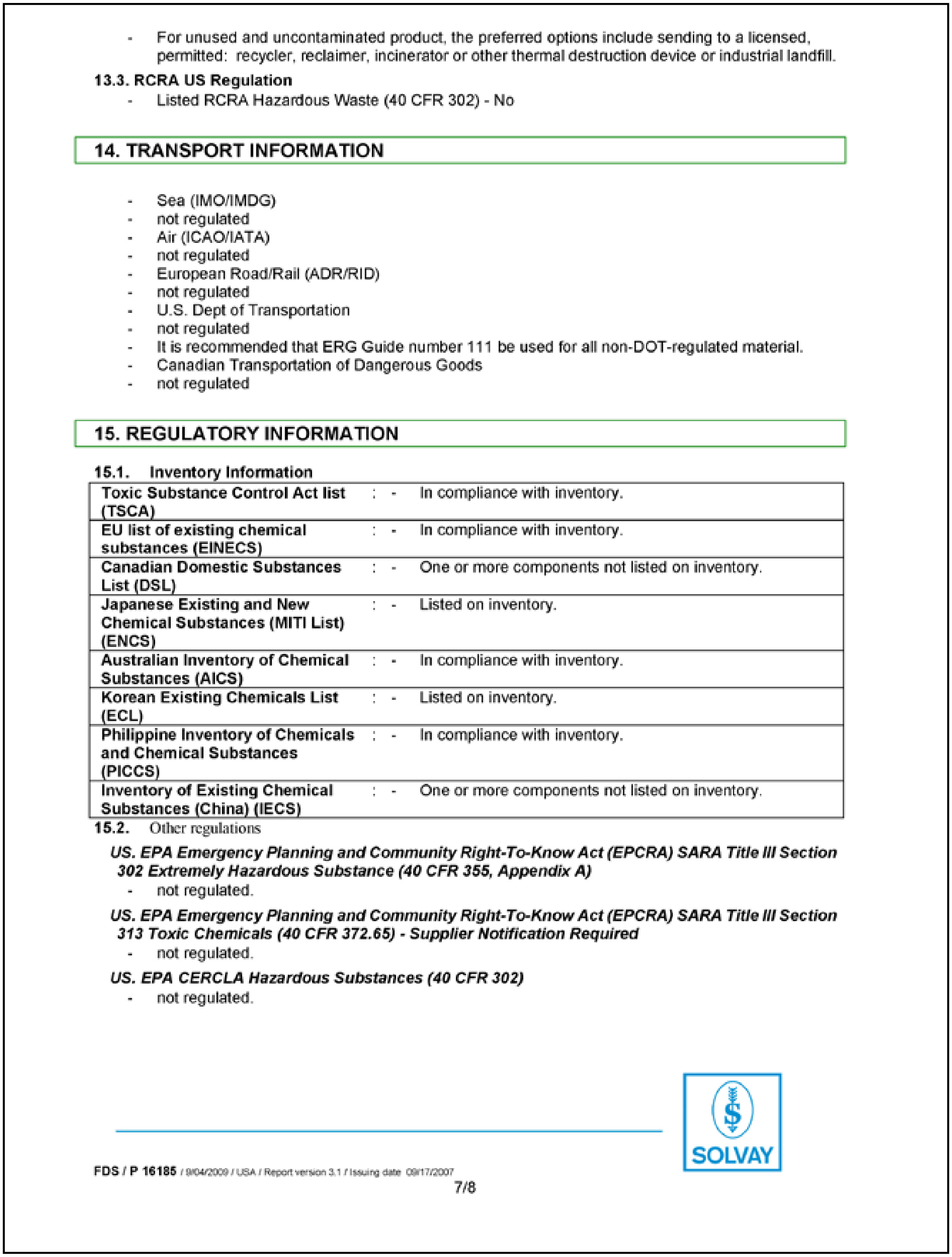

- For unused and uncontaminated product, the preferred options include sending to a licensed, permitted: recycler, reclaimer, incinerator or other thermal destruction device or industrial landfill.

13.3. RCRA US Regulation

- Listed RCRA Hazardous Waste (40 CFR 302) - No

14. TRANSPORT INFORMATION

- Sea (IMO/IMDG)
- not regulated
- Air (ICAO/IATA)
- not regulated
- European Road/Rail (ADR/RID)
- not regulated
- U.S. Dept of Transportation
- not regulated
- It is recommended that ERG Guide number 111 be used for all non-DOT-regulated material.
- Canadian Transportation of Dangerous Goods
- not regulated

15. REGULATORY INFORMATION

15.1. Inventory Information

Toxic Substance Control Act list (TSCA)	: -	In compliance with inventory.
EU list of existing chemical substances (EINECS)	: -	In compliance with inventory.
Canadian Domestic Substances List (DSL)	: -	One or more components not listed on inventory.
Japanese Existing and New Chemical Substances (MITI List) (ENCS)	: -	Listed on inventory.
Australian Inventory of Chemical Substances (AICS)	: -	In compliance with inventory.
Korean Existing Chemicals List (ECL)	: -	Listed on inventory.
Philippine Inventory of Chemicals and Chemical Substances (PICCS)	: -	In compliance with inventory.
Inventory of Existing Chemical Substances (China) (IECS)	: -	One or more components not listed on inventory.

15.2. Other regulations

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 302 Extremely Hazardous Substance (40 CFR 355, Appendix A)

- not regulated.

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 313 Toxic Chemicals (40 CFR 372.65) - Supplier Notification Required

- not regulated.

US. EPA CERCLA Hazardous Substances (40 CFR 302)

- not regulated.

SOLVAY

FDS / P 16185 / 9/04/2009 / USA / Report version 3.1 / Issuing date 09/17/2007

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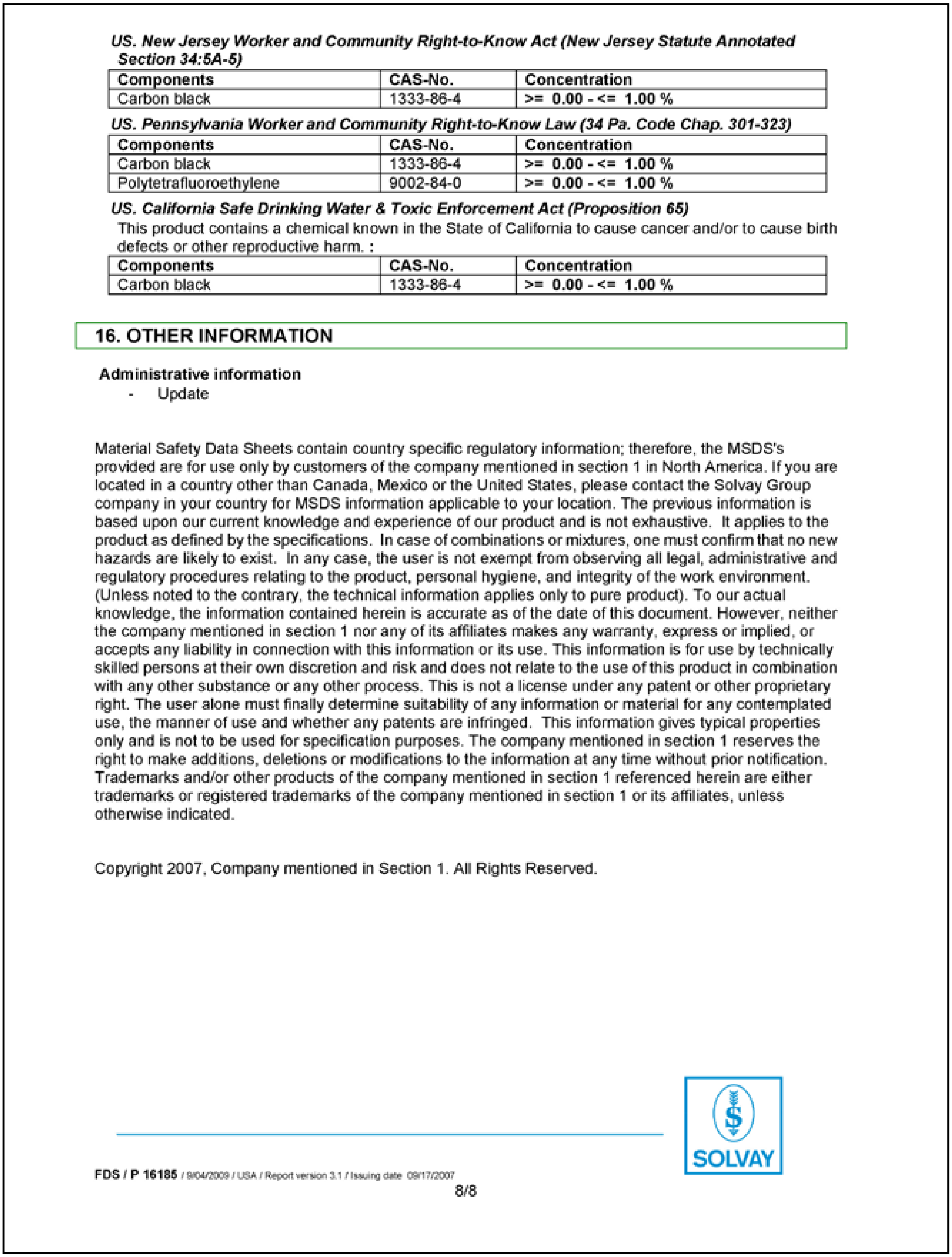


US. New Jersey Worker and Community Right-to-Know Act (New Jersey Statute Annotated Section 34:5A-5)

Components	CAS-No.	Concentration
Carbon black	1333-86-4	**>= 0.00 - <= 1.00 %**

US. Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)

Components	CAS-No.	Concentration
Carbon black	1333-86-4	**>= 0.00 - <= 1.00 %**
Polytetrafluoroethylene	9002-84-0	**>= 0.00 - <= 1.00 %**

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)

This product contains a chemical known in the State of California to cause cancer and/or to cause birth defects or other reproductive harm. :

Components	CAS-No.	Concentration
Carbon black	1333-86-4	**>= 0.00 - <= 1.00 %**

16. OTHER INFORMATION

Administrative information

- Update

Material Safety Data Sheets contain country specific regulatory information; therefore, the MSDS's provided are for use only by customers of the company mentioned in section 1 in North America. If you are located in a country other than Canada, Mexico or the United States, please contact the Solvay Group company in your country for MSDS information applicable to your location. The previous information is based upon our current knowledge and experience of our product and is not exhaustive. It applies to the product as defined by the specifications. In case of combinations or mixtures, one must confirm that no new hazards are likely to exist. In any case, the user is not exempt from observing all legal, administrative and regulatory procedures relating to the product, personal hygiene, and integrity of the work environment. (Unless noted to the contrary, the technical information applies only to pure product). To our actual knowledge, the information contained herein is accurate as of the date of this document. However, neither the company mentioned in section 1 nor any of its affiliates makes any warranty, express or implied, or accepts any liability in connection with this information or its use. This information is for use by technically skilled persons at their own discretion and risk and does not relate to the use of this product in combination with any other substance or any other process. This is not a license under any patent or other proprietary right. The user alone must finally determine suitability of any information or material for any contemplated use, the manner of use and whether any patents are infringed. This information gives typical properties only and is not to be used for specification purposes. The company mentioned in section 1 reserves the right to make additions, deletions or modifications to the information at any time without prior notification. Trademarks and/or other products of the company mentioned in section 1 referenced herein are either trademarks or registered trademarks of the company mentioned in section 1 or its affiliates, unless otherwise indicated.

SOLVAY

CHLORINE

0126
April 2000

CAS No: 7782-50-5 RTECS No: FO2100000 UN No: 1017 EC No: 017-001-00-7	(cylinder) Cl_2 Molecular mass: 70.9

TYPES OF HAZARD/ EXPOSURE	**ACUTE HAZARDS/SYMPTOMS**	**PREVENTION**	**FIRST AID/FIRE FIGHTING**
FIRE	Not combustible but enhances combustion of other substances. Many reactions may cause fire or explosion.	NO contact with combustibles, acetylene, ethylene, hydrogen, ammonia and finely divided metals.	In case of fire in the surroundings: use appropriate extinguishing media.
EXPLOSION	Risk of fire and explosion on contact with combustible substances, ammonia and finely divided metals.		In case of fire: keep cylinder cool by spraying with water but NO direct contact with water.

EXPOSURE		**AVOID ALL CONTACT!**	**IN ALL CASES CONSULT A DOCTOR!**
Inhalation	Corrosive. Burning sensation. Shortness of breath. Cough. Headache. Nausea. Dizziness. Laboured breathing. Sore throat. Symptoms may be delayed (see Notes).	Breathing protection. Closed system and ventilation.	Fresh air, rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
Skin	ON CONTACT WITH LIQUID: FROSTBITE. Corrosive. Skin burns. Pain.	Cold-insulating gloves. Protective clothing.	First rinse with plenty of water, then remove contaminated clothes and rinse again. Refer for medical attention.
Eyes	Corrosive. Pain. Blurred vision. Severe deep burns.	Safety goggles or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion			

SPILLAGE DISPOSAL	**PACKAGING & LABELLING**	
Evacuate danger area! Consult an expert! Ventilation. NEVER direct water jet on liquid. Remove gas with fine water spray. Personal protection: complete protective clothing including self-contained breathing apparatus. Do NOT let this chemical enter the environment.	T Symbol N Symbol R: 23-36/37/38-50 S: (1/2-)9-45-61 UN Hazard Class: 2.3 UN Subsidiary Risks: 8	Special insulated cylinder. Marine pollutant.

EMERGENCY RESPONSE	**SAFE STORAGE**
Transport Emergency Card: TEC (R)-20S1017 NFPA Code: H 4; F 0; R 0; OX	Separated from strong bases, combustible and reducing substances. Cool. Dry. Keep in a well-ventilated room.

IPCS
International Programme on Chemical Safety

UNEP

SEE IMPORTANT INFORMATION ON THE BACK.

0126 **CHLORINE**

IMPORTANT DATA

Physical State; Appearance
GREENISH-YELLOW GAS, WITH PUNGENT ODOUR.

Physical dangers
The gas is heavier than air.

Chemical dangers
The solution in water is a strong acid, it reacts violently with bases and is corrosive. Reacts violently with many organic compounds, ammonia, hydrogen and finely divided metals causing fire and explosion hazard. Attacks many metals in presence of water. Attacks plastic, rubber and coatings.

Occupational exposure limits
TLV: 0.5 ppm as TWA; 1 ppm as STEL; A4 (not classifiable as a human carcinogen); (ACGIH 2004).
MAK: 0.5 ppm, 1.5 mg/m^3; Peak limitation category: I(1); Pregnancy risk group: C; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation.

Inhalation risk
A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

Effects of short-term exposure
Tear drawing. The substance is corrosive to the eyes, the skin and the respiratory tract. Inhalation of gas may cause pneumonitis and lung oedema, resulting in reactive airways dysfunction syndrome (RADS) (see Notes). Rapid evaporation of the liquid may cause frostbite. Exposure far above the OEL may result in death. The effects may be delayed. Medical observation is indicated.

Effects of long-term or repeated exposure
The substance may have effects on the lungs, resulting in chronic bronchitis. The substance may have effects on the teeth, resulting in erosion.

PHYSICAL PROPERTIES

Boiling point: -34°C
Melting point: -101°C
Relative density (water = 1): 1.4 at 20°C, 6.86 atm (liquid)

Solubility in water, g/100 ml at 20°C: 0.7
Vapour pressure, kPa at 20°C: 673
Relative vapour density (air = 1): 2.5

ENVIRONMENTAL DATA

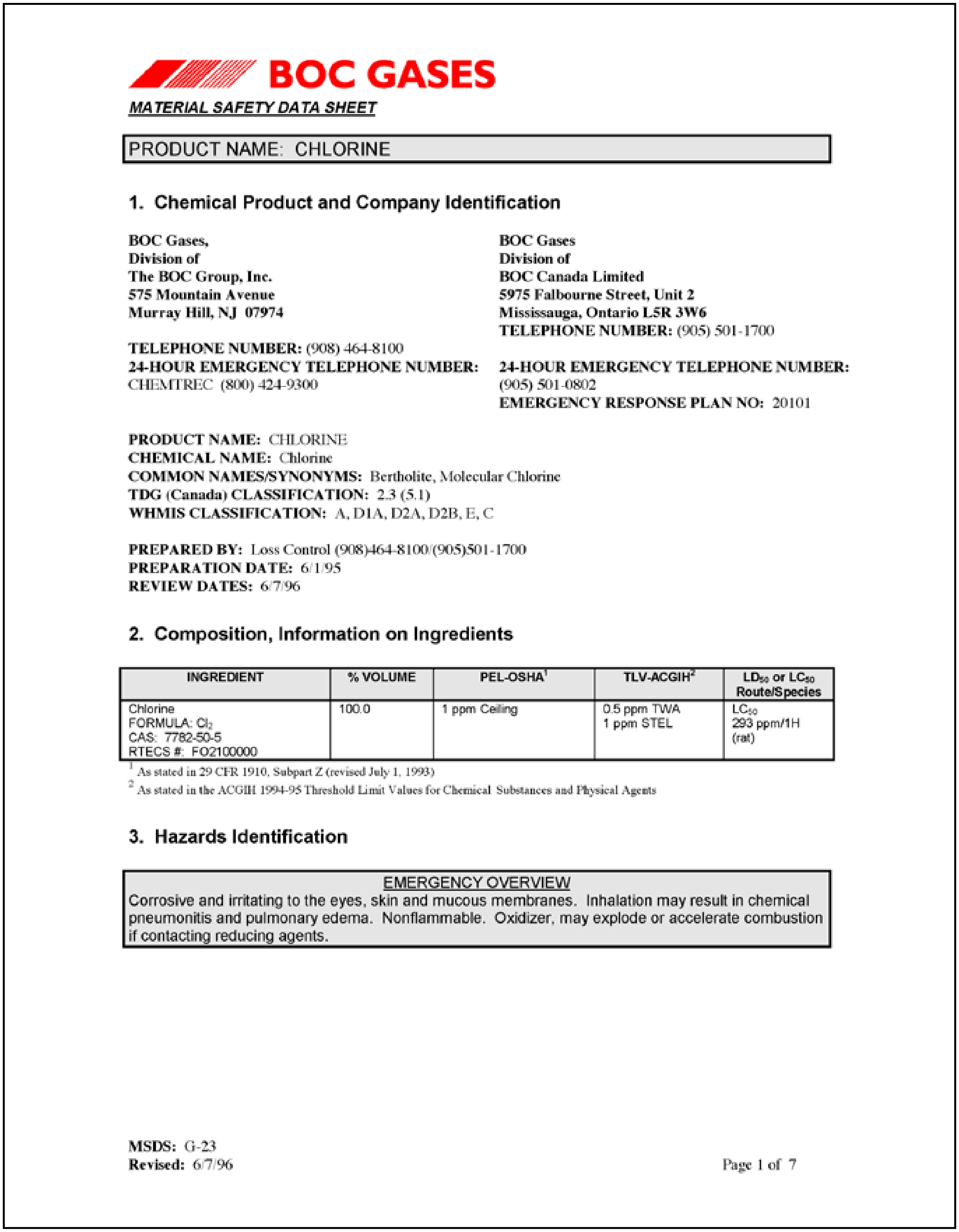
The substance is very toxic to aquatic organisms.

NOTES

The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential.
Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered.
The odour warning when the exposure limit value is exceeded is insufficient.
Do NOT use in the vicinity of a fire or a hot surface, or during welding.
Do NOT spray water on leaking cylinder (to prevent corrosion of cylinder).
Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.
Card has been partly updated in April 2005. See sections Occupational Exposure Limits, EU classification, Emergency Response.

ADDITIONAL INFORMATION

LEGAL NOTICE	Neither the EC nor the IPCS nor any person acting on behalf of the EC or the IPCS is responsible



BOC GASES

MATERIAL SAFETY DATA SHEET

PRODUCT NAME: CHLORINE

1. Chemical Product and Company Identification

BOC Gases,
Division of
The BOC Group, Inc.
575 Mountain Avenue
Murray Hill, NJ 07974

TELEPHONE NUMBER: (908) 464-8100
24-HOUR EMERGENCY TELEPHONE NUMBER:
CHEMTREC (800) 424-9300

BOC Gases
Division of
BOC Canada Limited
5975 Falbourne Street, Unit 2
Mississauga, Ontario L5R 3W6
TELEPHONE NUMBER: (905) 501-1700
24-HOUR EMERGENCY TELEPHONE NUMBER:
(905) 501-0802
EMERGENCY RESPONSE PLAN NO: 20101

PRODUCT NAME: CHLORINE
CHEMICAL NAME: Chlorine
COMMON NAMES/SYNONYMS: Bertholite, Molecular Chlorine
TDG (Canada) CLASSIFICATION: 2.3 (5.1)
WHMIS CLASSIFICATION: A, D1A, D2A, D2B, E, C

PREPARED BY: Loss Control (908)464-8100/(905)501-1700
PREPARATION DATE: 6/1/95
REVIEW DATES: 6/7/96

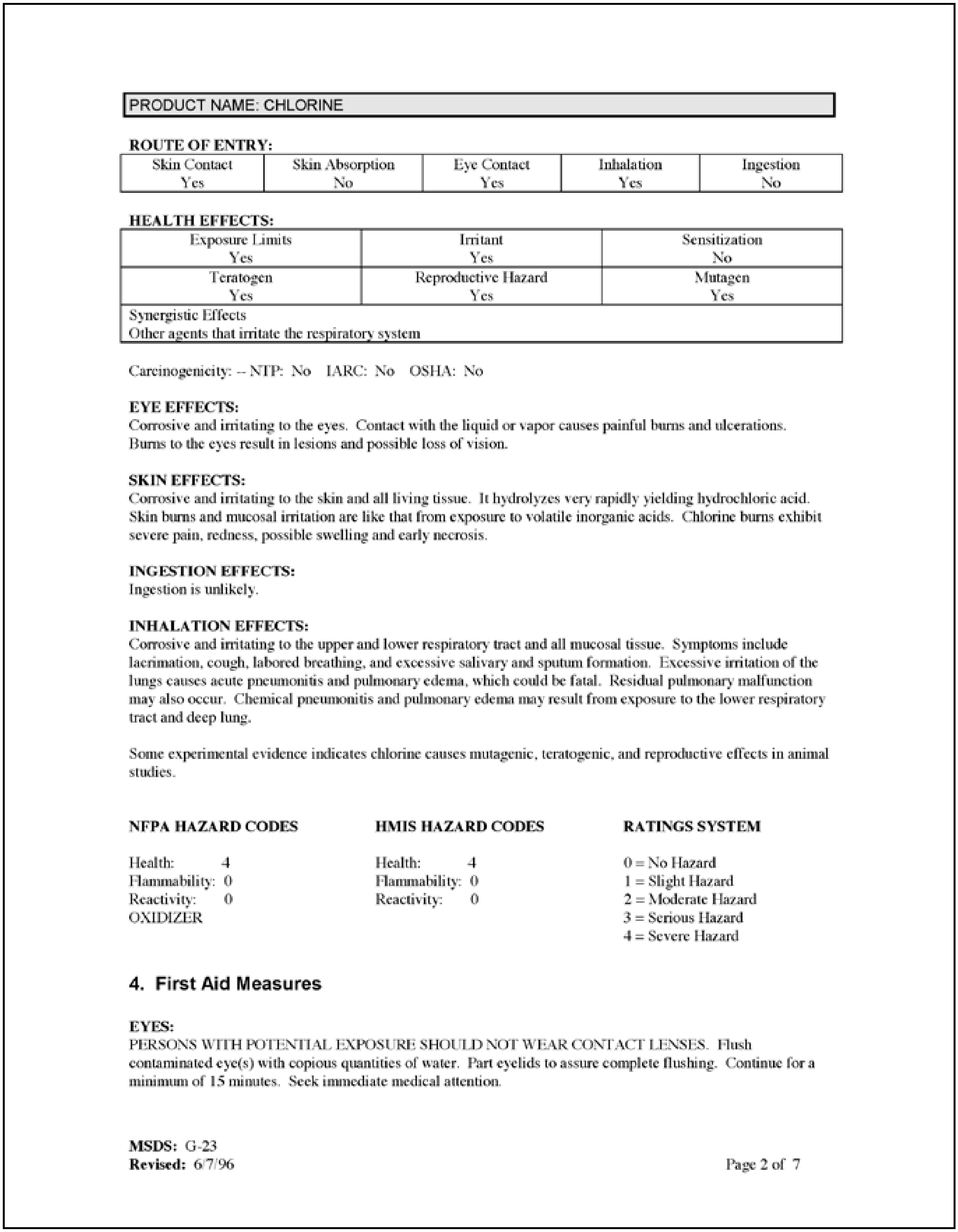
2. Composition, Information on Ingredients

INGREDIENT	% VOLUME	PEL-OSHA[1]	TLV-ACGIH[2]	LD_{50} or LC_{50} Route/Species
Chlorine FORMULA: Cl_2 CAS: 7782-50-5 RTECS #: FO2100000	100.0	1 ppm Ceiling	0.5 ppm TWA 1 ppm STEL	LC_{50} 293 ppm/1H (rat)

[1] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[2] As stated in the ACGIH 1994-95 Threshold Limit Values for Chemical Substances and Physical Agents

3. Hazards Identification

EMERGENCY OVERVIEW
Corrosive and irritating to the eyes, skin and mucous membranes. Inhalation may result in chemical pneumonitis and pulmonary edema. Nonflammable. Oxidizer, may explode or accelerate combustion if contacting reducing agents.



PRODUCT NAME: CHLORINE

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
Yes	No	Yes	Yes	No

HEALTH EFFECTS:

Exposure Limits Yes	Irritant Yes	Sensitization No
Teratogen Yes	Reproductive Hazard Yes	Mutagen Yes
Synergistic Effects Other agents that irritate the respiratory system		

Carcinogenicity: -- NTP: No IARC: No OSHA: No

EYE EFFECTS:
Corrosive and irritating to the eyes. Contact with the liquid or vapor causes painful burns and ulcerations. Burns to the eyes result in lesions and possible loss of vision.

SKIN EFFECTS:
Corrosive and irritating to the skin and all living tissue. It hydrolyzes very rapidly yielding hydrochloric acid. Skin burns and mucosal irritation are like that from exposure to volatile inorganic acids. Chlorine burns exhibit severe pain, redness, possible swelling and early necrosis.

INGESTION EFFECTS:
Ingestion is unlikely.

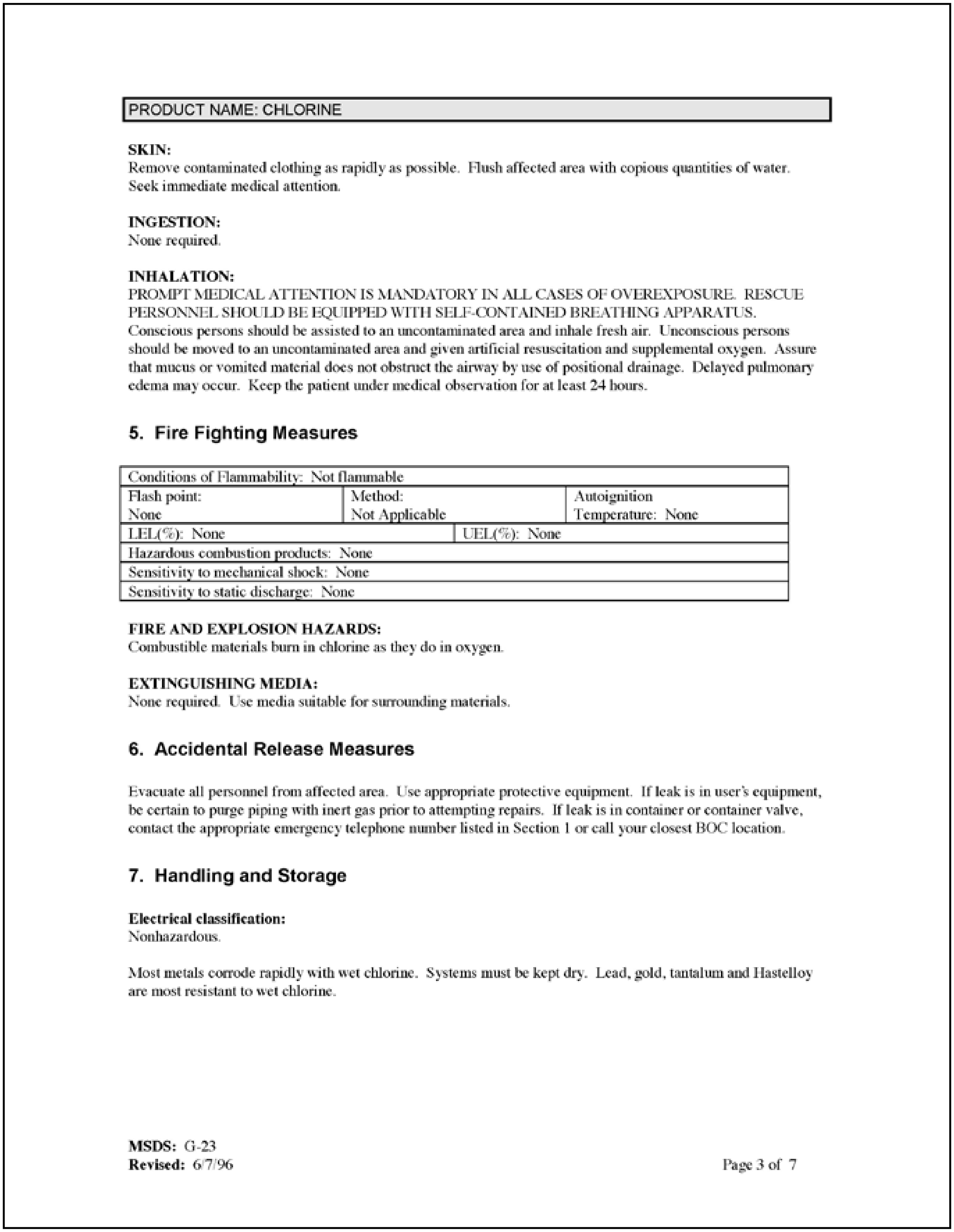
INHALATION EFFECTS:
Corrosive and irritating to the upper and lower respiratory tract and all mucosal tissue. Symptoms include lacrimation, cough, labored breathing, and excessive salivary and sputum formation. Excessive irritation of the lungs causes acute pneumonitis and pulmonary edema, which could be fatal. Residual pulmonary malfunction may also occur. Chemical pneumonitis and pulmonary edema may result from exposure to the lower respiratory tract and deep lung.

Some experimental evidence indicates chlorine causes mutagenic, teratogenic, and reproductive effects in animal studies.

NFPA HAZARD CODES	**HMIS HAZARD CODES**	**RATINGS SYSTEM**
Health: 4	Health: 4	0 = No Hazard
Flammability: 0	Flammability: 0	1 = Slight Hazard
Reactivity: 0	Reactivity: 0	2 = Moderate Hazard
OXIDIZER		3 = Serious Hazard
		4 = Severe Hazard

4. First Aid Measures

EYES:
PERSONS WITH POTENTIAL EXPOSURE SHOULD NOT WEAR CONTACT LENSES. Flush contaminated eye(s) with copious quantities of water. Part eyelids to assure complete flushing. Continue for a minimum of 15 minutes. Seek immediate medical attention.



PRODUCT NAME: CHLORINE

SKIN:
Remove contaminated clothing as rapidly as possible. Flush affected area with copious quantities of water. Seek immediate medical attention.

INGESTION:
None required.

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Unconscious persons should be moved to an uncontaminated area and given artificial resuscitation and supplemental oxygen. Assure that mucus or vomited material does not obstruct the airway by use of positional drainage. Delayed pulmonary edema may occur. Keep the patient under medical observation for at least 24 hours.

5. Fire Fighting Measures

Conditions of Flammability: Not flammable		
Flash point: None	Method: Not Applicable	Autoignition Temperature: None
LEL(%): None	UEL(%): None	
Hazardous combustion products: None		
Sensitivity to mechanical shock: None		
Sensitivity to static discharge: None		

FIRE AND EXPLOSION HAZARDS:
Combustible materials burn in chlorine as they do in oxygen.

EXTINGUISHING MEDIA:
None required. Use media suitable for surrounding materials.

6. Accidental Release Measures

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone number listed in Section 1 or call your closest BOC location.

7. Handling and Storage

Electrical classification:
Nonhazardous.

Most metals corrode rapidly with wet chlorine. Systems must be kept dry. Lead, gold, tantalum and Hastelloy are most resistant to wet chlorine.

PRODUCT NAME: CHLORINE

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<250 psig) piping or systems. Do not heat cylinder by any means to increase rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into cylinder.

Protect cylinders from physical damage. Store in cool, dry, well-ventilated areas of non-combustible construction away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 125°F (52°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full & empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time.

For additional storage recommendations, consult Compressed Gas Association's Pamphlet P-1.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

8. Exposure Controls, Personal Protection

EXPOSURE LIMITS[1]:

INGREDIENT	% VOLUME	PEL-OSHA[2]	TLV-ACGIH[3]	LD_{50} or LC_{50} Route/Species
Chlorine FORMULA: Cl_2 CAS: 7782-50-5 RTECS #: FO2100000	100.0	1 ppm Ceiling	0.5 ppm TWA 1 ppm STEL	LC_{50} 293 ppm/1H (rat)

[1] Refer to individual state of provincial regulations, as applicable, for limits which may be more stringent than those listed here.
[2] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[3] As stated in the ACGIH 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents.

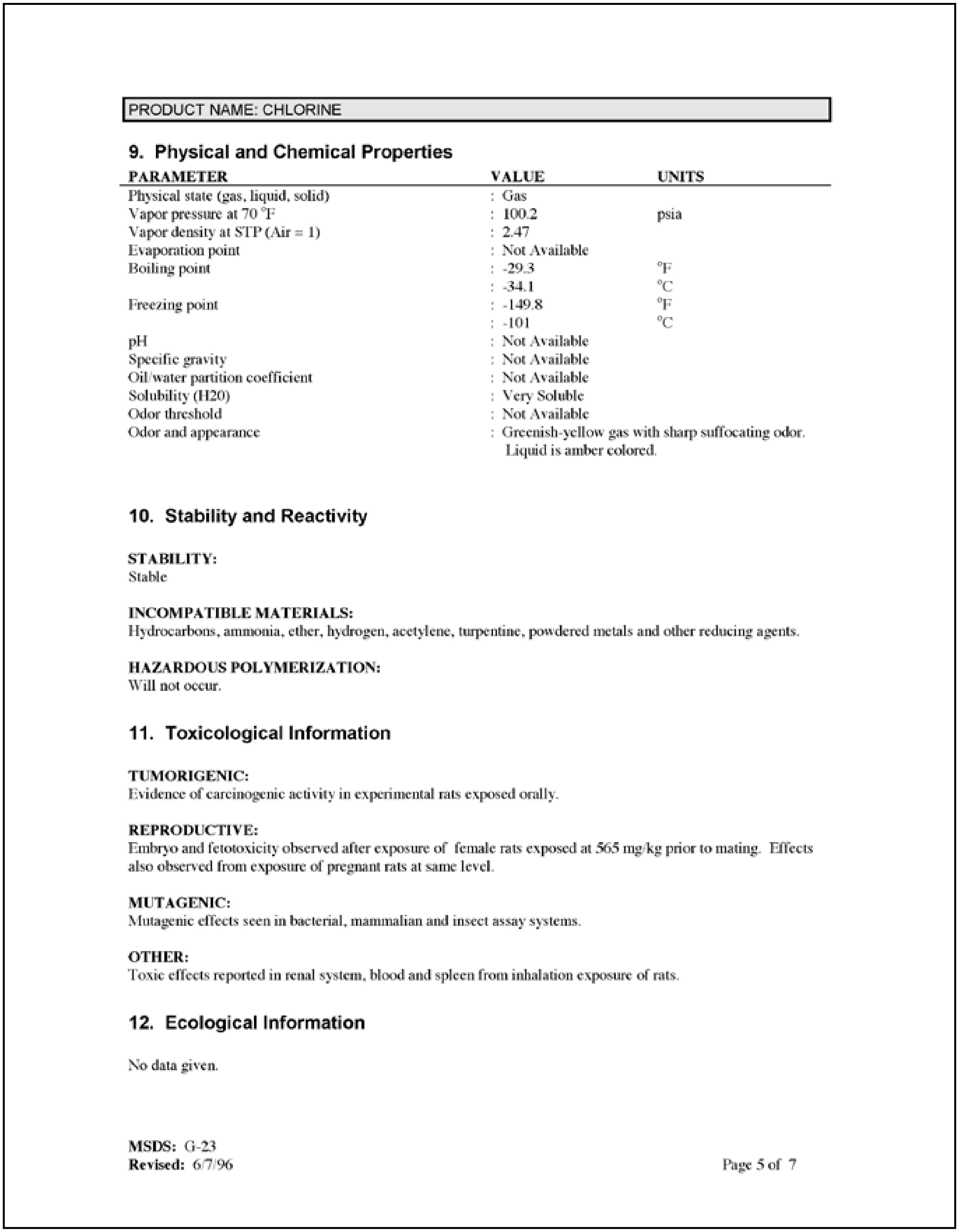
ENGINEERING CONTROLS:
Hood with forced ventilation. Use local ventilation to prevent accumulation above the exposure limit.

EYE/FACE PROTECTION:
Gas-tight safety goggles or full-face respirator.

SKIN PROTECTION:
PVC, Kel-F ® or Teflon ®.

RESPIRATORY PROTECTION:
Positive pressure air line with full-face mask and escape bottle or self-contained breathing apparatus should be available for emergency use.

OTHER/GENERAL PROTECTION:
Safety shoes, safety shower, eyewash "fountain", face shield.



PRODUCT NAME: CHLORINE

9. Physical and Chemical Properties

PARAMETER	VALUE	UNITS
Physical state (gas, liquid, solid)	: Gas	
Vapor pressure at 70 °F	: 100.2	psia
Vapor density at STP (Air = 1)	: 2.47	
Evaporation point	: Not Available	
Boiling point	: -29.3	°F
	: -34.1	°C
Freezing point	: -149.8	°F
	: -101	°C
pH	: Not Available	
Specific gravity	: Not Available	
Oil/water partition coefficient	: Not Available	
Solubility (H20)	: Very Soluble	
Odor threshold	: Not Available	
Odor and appearance	: Greenish-yellow gas with sharp suffocating odor. Liquid is amber colored.	

10. Stability and Reactivity

STABILITY:
Stable

INCOMPATIBLE MATERIALS:
Hydrocarbons, ammonia, ether, hydrogen, acetylene, turpentine, powdered metals and other reducing agents.

HAZARDOUS POLYMERIZATION:
Will not occur.

11. Toxicological Information

TUMORIGENIC:
Evidence of carcinogenic activity in experimental rats exposed orally.

REPRODUCTIVE:
Embryo and fetotoxicity observed after exposure of female rats exposed at 565 mg/kg prior to mating. Effects also observed from exposure of pregnant rats at same level.

MUTAGENIC:
Mutagenic effects seen in bacterial, mammalian and insect assay systems.

OTHER:
Toxic effects reported in renal system, blood and spleen from inhalation exposure of rats.

12. Ecological Information

No data given.

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Revised: 6/7/96

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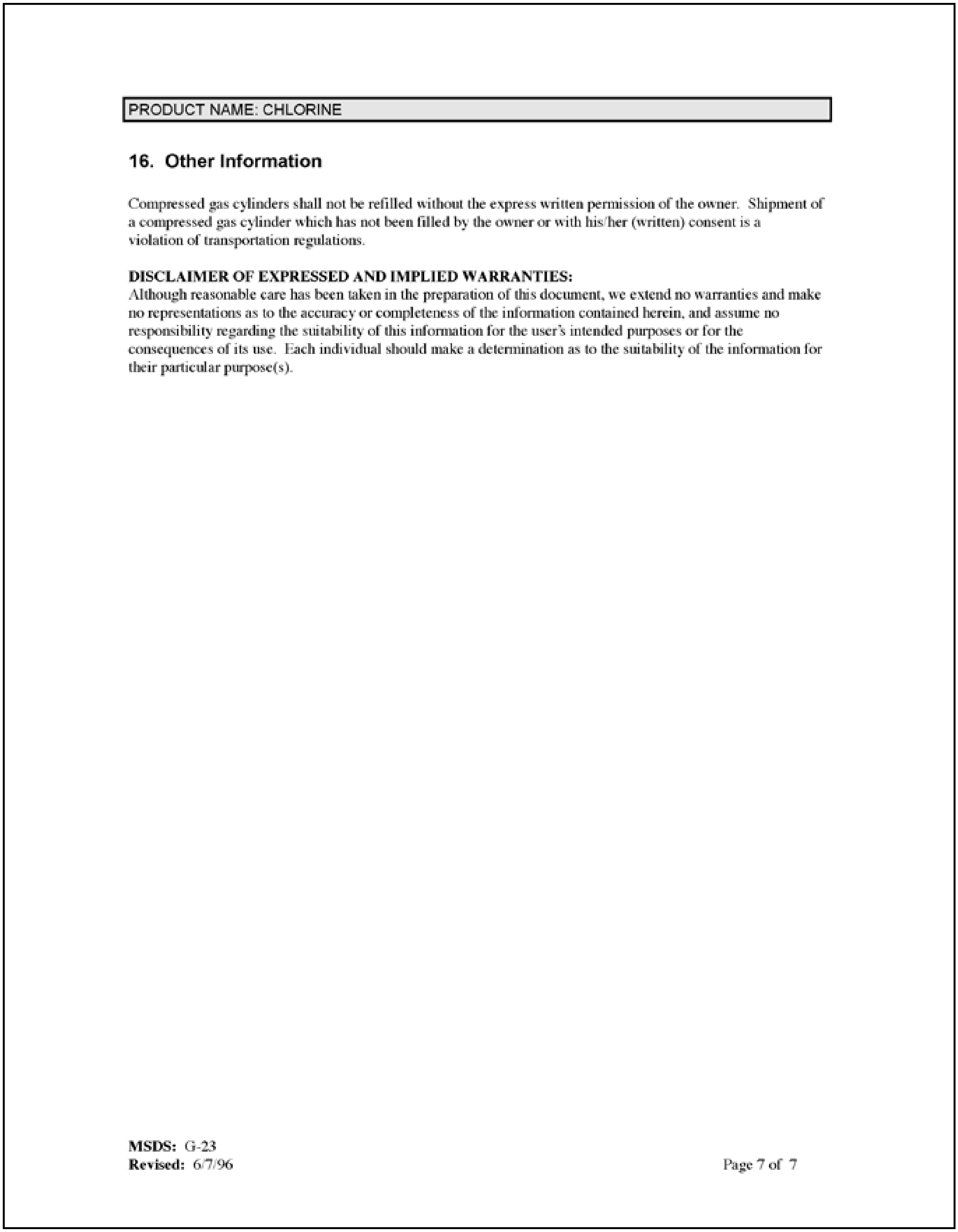

PRODUCT NAME: CHLORINE

16. Other Information

Compressed gas cylinders shall not be refilled without the express written permission of the owner. Shipment of a compressed gas cylinder which has not been filled by the owner or with his/her (written) consent is a violation of transportation regulations.

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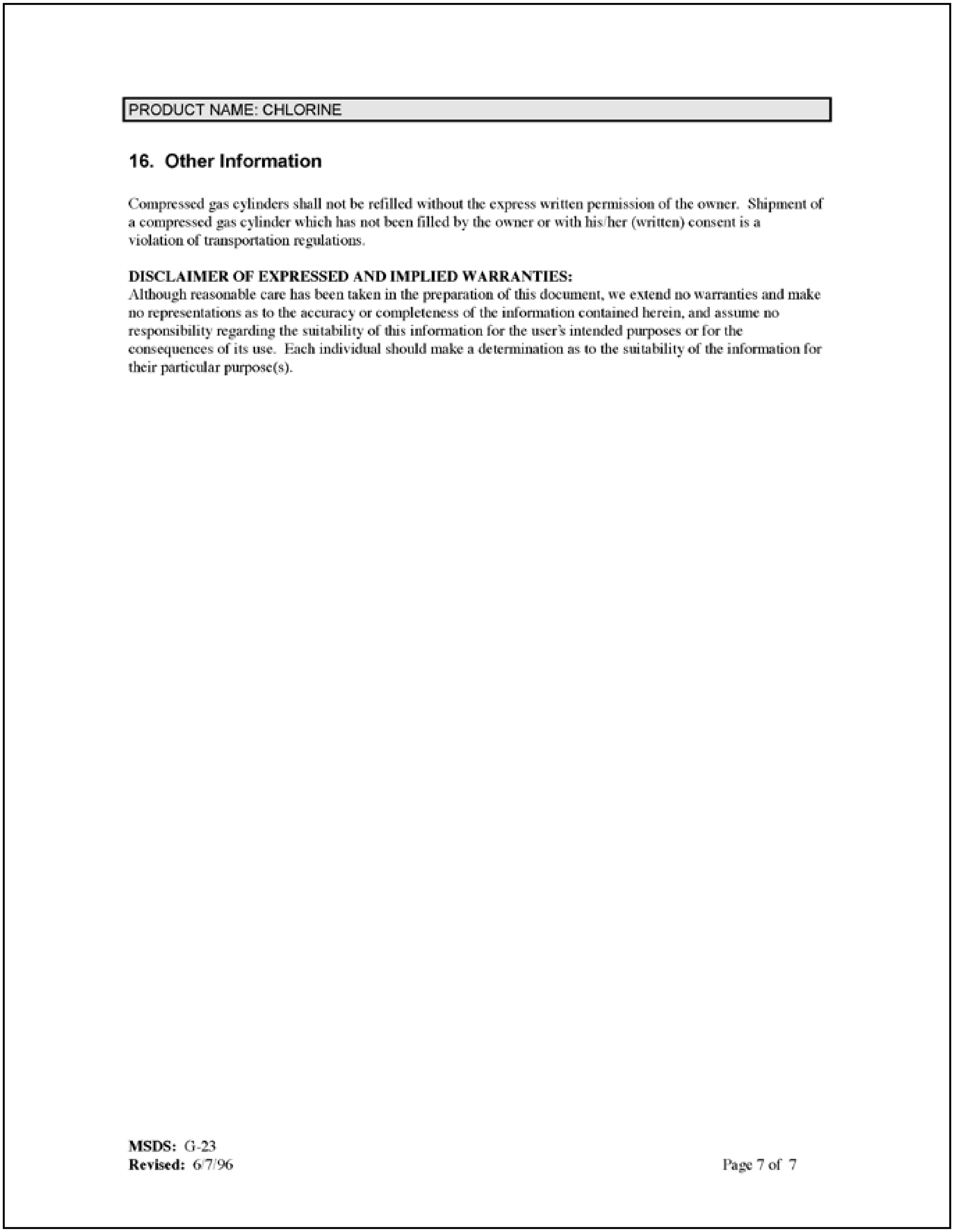

PRODUCT NAME: CHLORINE

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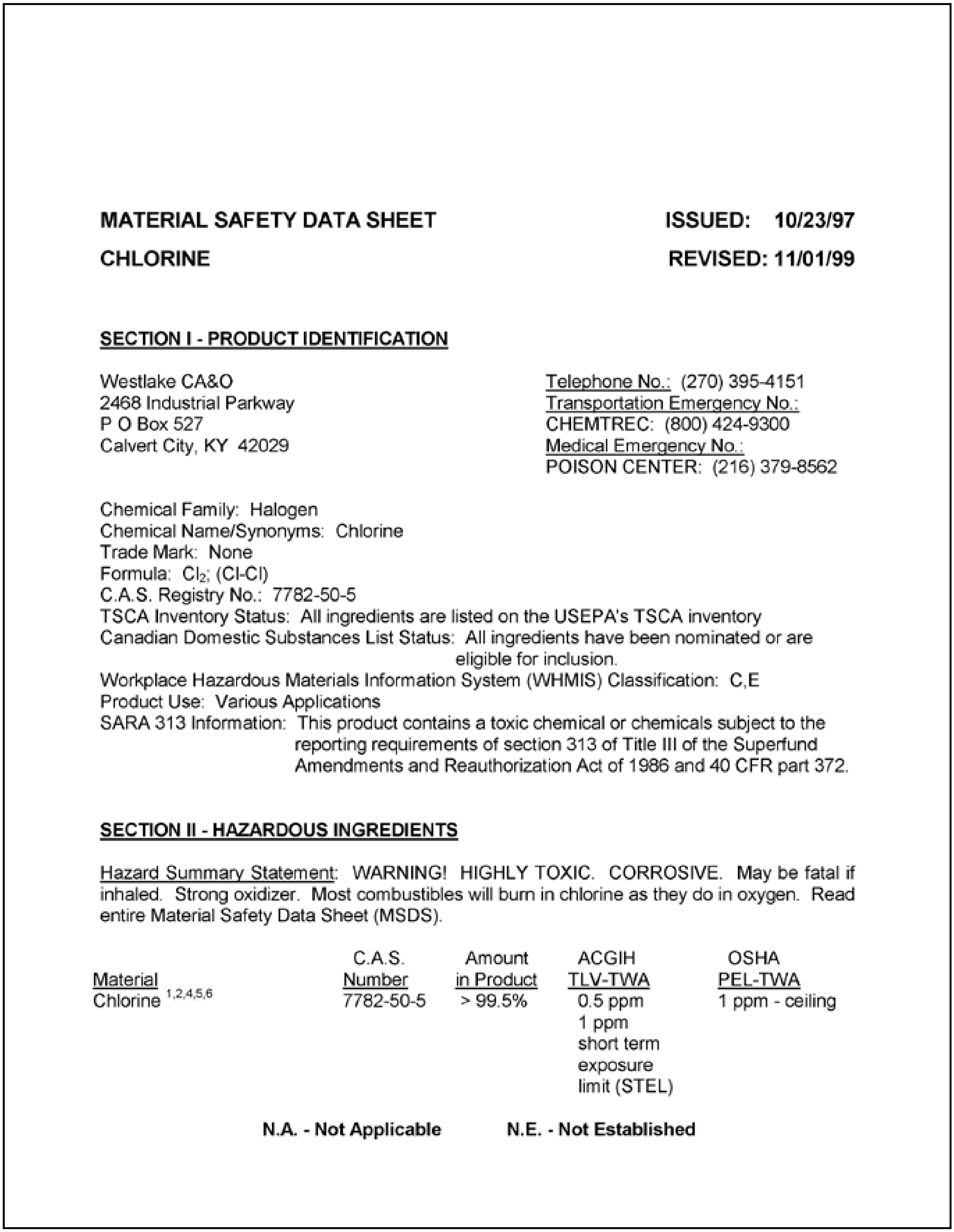
MSDS: G-23
Revised: 6/7/96



MATERIAL SAFETY DATA SHEET **ISSUED: 10/23/97**

CHLORINE **REVISED: 11/01/99**

SECTION I - PRODUCT IDENTIFICATION

Westlake CA&O
2468 Industrial Parkway
P O Box 527
Calvert City, KY 42029

Telephone No.: (270) 395-4151
Transportation Emergency No.:
CHEMTREC: (800) 424-9300
Medical Emergency No.:
POISON CENTER: (216) 379-8562

Chemical Family: Halogen
Chemical Name/Synonyms: Chlorine
Trade Mark: None
Formula: Cl_2; (Cl-Cl)
C.A.S. Registry No.: 7782-50-5
TSCA Inventory Status: All ingredients are listed on the USEPA's TSCA inventory
Canadian Domestic Substances List Status: All ingredients have been nominated or are eligible for inclusion.
Workplace Hazardous Materials Information System (WHMIS) Classification: C,E
Product Use: Various Applications
SARA 313 Information: This product contains a toxic chemical or chemicals subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

SECTION II - HAZARDOUS INGREDIENTS

Hazard Summary Statement: WARNING! HIGHLY TOXIC. CORROSIVE. May be fatal if inhaled. Strong oxidizer. Most combustibles will burn in chlorine as they do in oxygen. Read entire Material Safety Data Sheet (MSDS).

Material	C.A.S. Number	Amount in Product	ACGIH TLV-TWA	OSHA PEL-TWA
Chlorine ^{1,2,4,5,6}	7782-50-5	> 99.5%	0.5 ppm 1 ppm short term exposure limit (STEL)	1 ppm - ceiling

N.A. - Not Applicable **N.E. - Not Established**

Legislative Footnotes

[1] Ingredient listed on SARA Section 313 List of Toxic Chemicals.

[2] Ingredient listed on the *Pennsylvania Hazardous Substances List*.

[3] Ingredient listed on the California listing of *Chemicals Known to the State to Cause Cancer or Reproductive Toxicity*.

[4] Ingredient listed on the *Massachusetts Substance List*.

[5] *Workplace Hazardous Materials Information System* ingredient found on the Ingredient Disclosure List - Canada.

[6] Ingredient listed on the *New Jersey Right to Know Hazardous Substance List*.

Notes:

TLV-TWA - Threshold Limit Value - Time Weighted Average guideline for concentration of the chemical substance in the ambient workplace air. (The skin notation calls attention to the skin as an additional significant route of absorption of the listed chemical.) American Conference of Governmental Industrial Hygienists (ACGIH).

OSHA PEL - OSHA Permissible Exposure Limit, 8-hour TWA. 29 CFR 1910.1000, Transitional Limits column, Table Z-1-A, Table Z-2, and Table Z-3.

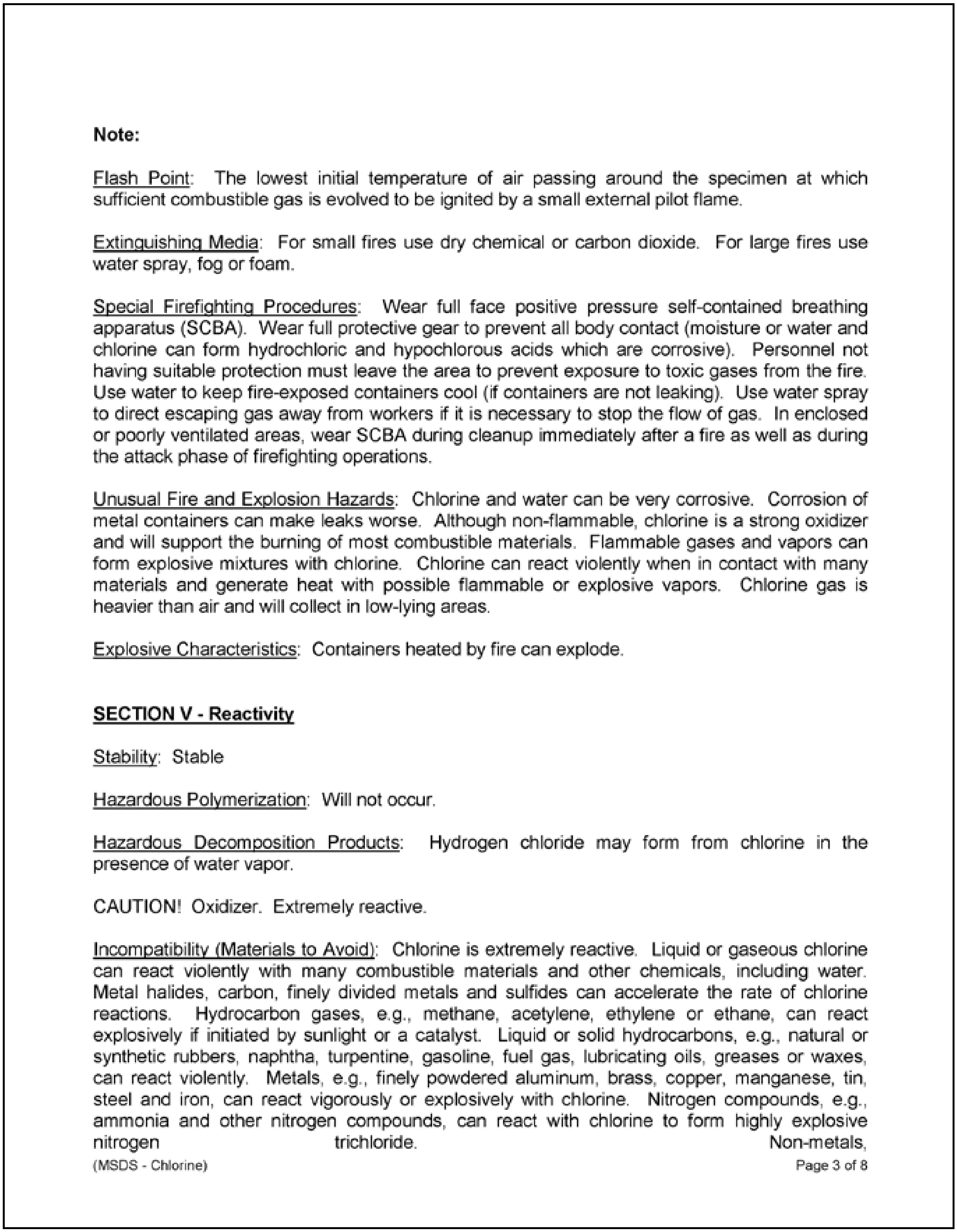
SECTION III - PHYSICAL DATA

Appearance: Greenish-yellow gas or amber liquid	Specific Gravity: Dry Gas (2.48 @ 0°C) Liquid (1.47 @ 0/4°C)
Odor: Pungent, suffocating bleach like odor	Melting Point: -101°C (-150°F)
	Molecular Weight: 70.9
Percent Volatiles: >99.5	Vapor Pressure: 73 psia @ 50°F
Solubility in Water: Slight	Vapor Density: 2.5 (Air=1)
Physical State: Gas (liquid under pressure)	

SECTION IV - FIRE & EXPLOSION HAZARD DATA

Flash Point: Test is not applicable to gases. Not combustible. Chlorine can support combustion and is a serious fire risk.

Flammable Limits in Air: Not Applicable



Note:

Flash Point: The lowest initial temperature of air passing around the specimen at which sufficient combustible gas is evolved to be ignited by a small external pilot flame.

Extinguishing Media: For small fires use dry chemical or carbon dioxide. For large fires use water spray, fog or foam.

Special Firefighting Procedures: Wear full face positive pressure self-contained breathing apparatus (SCBA). Wear full protective gear to prevent all body contact (moisture or water and chlorine can form hydrochloric and hypochlorous acids which are corrosive). Personnel not having suitable protection must leave the area to prevent exposure to toxic gases from the fire. Use water to keep fire-exposed containers cool (if containers are not leaking). Use water spray to direct escaping gas away from workers if it is necessary to stop the flow of gas. In enclosed or poorly ventilated areas, wear SCBA during cleanup immediately after a fire as well as during the attack phase of firefighting operations.

Unusual Fire and Explosion Hazards: Chlorine and water can be very corrosive. Corrosion of metal containers can make leaks worse. Although non-flammable, chlorine is a strong oxidizer and will support the burning of most combustible materials. Flammable gases and vapors can form explosive mixtures with chlorine. Chlorine can react violently when in contact with many materials and generate heat with possible flammable or explosive vapors. Chlorine gas is heavier than air and will collect in low-lying areas.

Explosive Characteristics: Containers heated by fire can explode.

SECTION V - Reactivity

Stability: Stable

Hazardous Polymerization: Will not occur.

Hazardous Decomposition Products: Hydrogen chloride may form from chlorine in the presence of water vapor.

CAUTION! Oxidizer. Extremely reactive.

Incompatibility (Materials to Avoid): Chlorine is extremely reactive. Liquid or gaseous chlorine can react violently with many combustible materials and other chemicals, including water. Metal halides, carbon, finely divided metals and sulfides can accelerate the rate of chlorine reactions. Hydrocarbon gases, e.g., methane, acetylene, ethylene or ethane, can react explosively if initiated by sunlight or a catalyst. Liquid or solid hydrocarbons, e.g., natural or synthetic rubbers, naphtha, turpentine, gasoline, fuel gas, lubricating oils, greases or waxes, can react violently. Metals, e.g., finely powdered aluminum, brass, copper, manganese, tin, steel and iron, can react vigorously or explosively with chlorine. Nitrogen compounds, e.g., ammonia and other nitrogen compounds, can react with chlorine to form highly explosive nitrogen trichloride. Non-metals, e.g., phosphorous, boron, activated carbon and silicon can ignite on contact with gaseous chlorine at room temperature. Certain concentrations of chlorine-hydrogen can explode by spark ignition. Chlorine is strongly corrosive to most metals in the presence of moisture. Copper may burn spontaneously. Chlorine reacts with most metals at high temperatures. Titanium will burn at ambient temperature in the presence of dry chlorine.

SECTION VI - HEALTH HAZARD DATA

Threshold Limit Value: See Section II.

Primary Routes of Exposure: Inhalation, skin and eye contact.

Effects of Overexposure:

Acute: Low concentrations of chlorine can cause itching and burning of the eyes, nose, throat and respiratory tract. At high concentrations chlorine is a respiratory poison. Irritant effects become severe and may be accompanied by tearing of the eyes, headache, coughing, choking, chest pain, shortness of breath, dizziness, nausea, vomiting, unconsciousness and death. Bronchitis and accumulation of fluid in the lungs (chemical pneumonia) may occur hours after exposure to high levels. Liquid as well as vapor contact can cause irritation, burns and blisters. Ingestion can cause nausea and severe burns of the mouth, esophagus and stomach.

Chronic: Prolonged or repeated overexposure may result in many or all of the effects reported for acute exposure (including pulmonary function effects).

Emergency and First Aid Procedures:

Inhalation (of process emissions): Take proper precautions to ensure rescuer safety before attempting rescue (wear appropriate protective equipment and utilize the "buddy system"). Remove source of chlorine or move victim to fresh air. If breathing has stopped, trained personnel should immediately begin artificial respiration or, if the heart has stopped, cardiopulmonary resuscitation (CPR). Avoid mouth-to-mouth contact. Oxygen may be beneficial if administered by a person trained in its use, preferably on a physician's advise. Obtain medical attention immediately.

Eye Contact: Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for at least 20 minutes while the eyelid(s) are open. Take care not to rinse contaminated water into the non-affected eye. If irritation persists, obtain medical attention immediately.

Skin Contact: As quickly as possible, flush contaminated area with lukewarm, gently running water for at least 20 minutes. Under running water, remove contaminated clothing, shoes, and leather watchbands and belts. If irritation persists, obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before re-use, or, discard.

Ingestion: Not an anticipated hazard.

SECTION VII - SPILL & LEAK PROCEDURE

Steps to be taken in case material is released or spilled: Restrict access to the area until completion of the cleanup. Issue a warning: POISON GAS. DO NOT TOUCH SPILLED LIQUID. Do no use water on a chlorine leak (corrosion of the container can occur, increasing the leak). Shut off leak if safe to do so. Wear NIOSH/MSHA-approved, self-contained, full-face, positive pressure respirator and full protective clothing capable of protection from both liquid and gas phases. Persons without suitable respiratory and body protection must leave the area.

The following evacuation guide was developed by the U.S. Department of Transportation (DOT): Spill or leak from a smaller container or small leak from a tank - isolate in all directions 250 feet. Large spill from a tank or from a number of containers - first, isolate 520 feet in all directions; secondly, evacuate in a downwind direction 1.3 miles wide and 2.0 miles long. Keep upwind from leak. Vapors are heavier than air and pockets of chlorine are likely to be trapped in low-lying areas. Use water spray on the chlorine vapor cloud to reduce vapors. Do not flush into public sewer or water systems. Chlorine can be neutralized with caustic soda or soda ash. Alkaline solutions for absorbing chlorine can be prepared as follows:

For 100 pound containers: 125 lbs. of caustic soda and 40 gallons of water
For 2,000 pound containers: 2,500 lbs. of caustic soda and 800 gallons of water
For 100 pound containers: 300 lbs. of soda ash and 100 gallons of water
For 2,000 pound containers: 6,000 lbs. of soda ash and 2,000 gallons of water

CAUTION: Observe appropriate safety precautions for handling alkaline chemicals. Heat will be generated during the neutralization process.

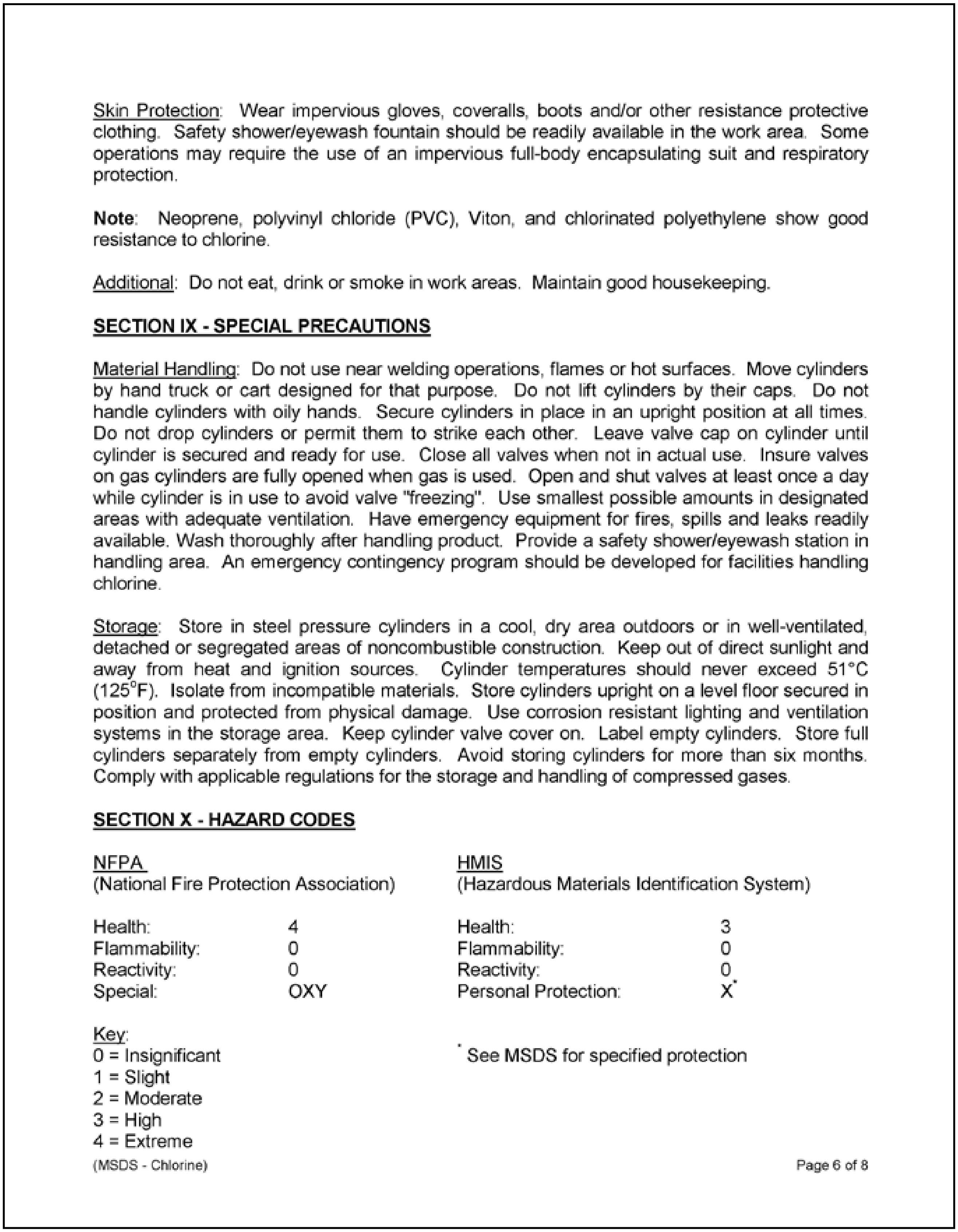
Waste Disposal Method: Due to its inherent properties, hazardous conditions may result if the material is managed improperly. It is recommended that any containerized waste chlorine be managed as hazardous waste in accordance with all applicable federal, state, and local health and environmental laws and regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Ventilation: Effective exhaust ventilation should always be provided to draw fumes or vapors away from workers to prevent routine inhalation. Ventilation should be adequate to maintain the ambient workplace atmosphere below the legislated levels listed in Section II.

Respiratory Protection: Use NIOSH approved acid gas cartridge or canister respirator for routine work purposes when concentrations are above the permissible exposure limits. Use full facepiece respirators when concentrations are irritating to the eyes. A cartridge-type escape respirator should be carried at all times when handling chlorine for escape only in case of a spill or leak. Re-enter area only with NIOSH approved, self-contained breathing apparatus with full facepiece. The respiratory use limitations made by NIOSH or the manufacturer must be observed. Respiratory protection programs must be in accordance with 29 CFR 1910.134.

Eye/Face Protection: Non-ventilated chemical safety goggles or a full face shield.



Skin Protection: Wear impervious gloves, coveralls, boots and/or other resistance protective clothing. Safety shower/eyewash fountain should be readily available in the work area. Some operations may require the use of an impervious full-body encapsulating suit and respiratory protection.

Note: Neoprene, polyvinyl chloride (PVC), Viton, and chlorinated polyethylene show good resistance to chlorine.

Additional: Do not eat, drink or smoke in work areas. Maintain good housekeeping.

SECTION IX - SPECIAL PRECAUTIONS

Material Handling: Do not use near welding operations, flames or hot surfaces. Move cylinders by hand truck or cart designed for that purpose. Do not lift cylinders by their caps. Do not handle cylinders with oily hands. Secure cylinders in place in an upright position at all times. Do not drop cylinders or permit them to strike each other. Leave valve cap on cylinder until cylinder is secured and ready for use. Close all valves when not in actual use. Insure valves on gas cylinders are fully opened when gas is used. Open and shut valves at least once a day while cylinder is in use to avoid valve "freezing". Use smallest possible amounts in designated areas with adequate ventilation. Have emergency equipment for fires, spills and leaks readily available. Wash thoroughly after handling product. Provide a safety shower/eyewash station in handling area. An emergency contingency program should be developed for facilities handling chlorine.

Storage: Store in steel pressure cylinders in a cool, dry area outdoors or in well-ventilated, detached or segregated areas of noncombustible construction. Keep out of direct sunlight and away from heat and ignition sources. Cylinder temperatures should never exceed 51°C (125°F). Isolate from incompatible materials. Store cylinders upright on a level floor secured in position and protected from physical damage. Use corrosion resistant lighting and ventilation systems in the storage area. Keep cylinder valve cover on. Label empty cylinders. Store full cylinders separately from empty cylinders. Avoid storing cylinders for more than six months. Comply with applicable regulations for the storage and handling of compressed gases.

SECTION X - HAZARD CODES

NFPA (National Fire Protection Association)		HMIS (Hazardous Materials Identification System)	
Health:	4	Health:	3
Flammability:	0	Flammability:	0
Reactivity:	0	Reactivity:	0
Special:	OXY	Personal Protection:	X*

Key:
0 = Insignificant
1 = Slight
2 = Moderate
3 = High
4 = Extreme

* See MSDS for specified protection

(MSDS - Chlorine)

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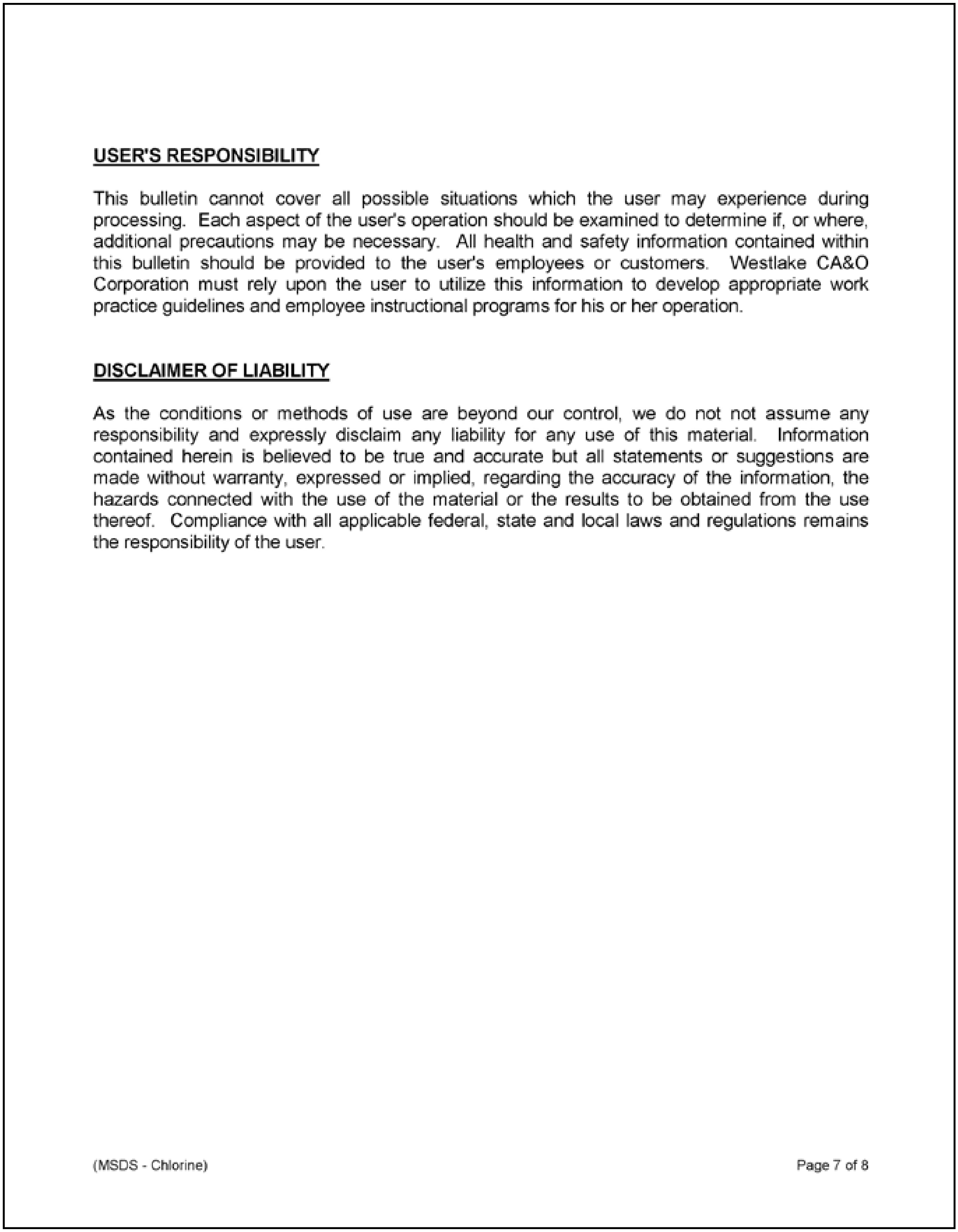


USER'S RESPONSIBILITY

This bulletin cannot cover all possible situations which the user may experience during processing. Each aspect of the user's operation should be examined to determine if, or where, additional precautions may be necessary. All health and safety information contained within this bulletin should be provided to the user's employees or customers. Westlake CA&O Corporation must rely upon the user to utilize this information to develop appropriate work practice guidelines and employee instructional programs for his or her operation.

DISCLAIMER OF LIABILITY

As the conditions or methods of use are beyond our control, we do not not assume any responsibility and expressly disclaim any liability for any use of this material. Information contained herein is believed to be true and accurate but all statements or suggestions are made without warranty, expressed or implied, regarding the accuracy of the information, the hazards connected with the use of the material or the results to be obtained from the use thereof. Compliance with all applicable federal, state and local laws and regulations remains the responsibility of the user.

SHIPPING INFORMATION

IDENTIFICATION - DOMESTIC TRANSPORTATION

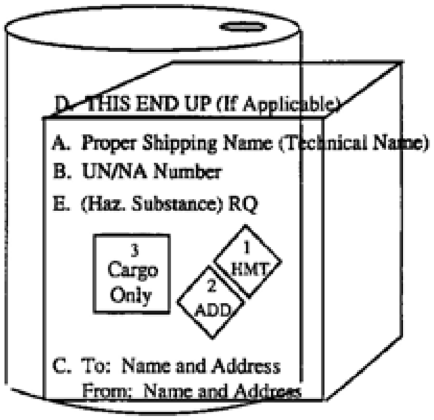
Proper Shipping Name (172.101(c)): **Chlorine**
(Technical Name(s)) 172.203(k): **N/A**
Hazard Class 172.101(d): **2.3**
UN/NA# 172.101(e): **UN 1017**
Haz. Substance 171.8: **RQ (Chlorine)**
Reportable Quantity (Appendix A to 172.101): **10 LB**
Inhalation Hazard 172.2a(b): **Zone B, Poison-Inhalation Hazard, Marine Pollutant**
Package Code 172.101(f): **N/A**
Placarded: **Poison Gas**

PACKAGING (Part 173)

- Packaging Section (172.101(i)) - Col. 8(a): None
  Col. 8(b): 173.304
  Col. 8(c): 173.314, 173.315
- General Packaging Section - General 173.24 Hazard Class: **POISON GAS**

MARKING

A. Proper Shipping Name (172.301(a)) (Technical Name) (172.301(b))
B. UN/NA Number (172.301(a))
C. Name & Address (172.301(d))
D. THIS END UP (172.312(a))
E. Hazardous Substance RQ (Name) (172.324)
ORM Designation (172.316(a))
Inhalation Hazard (172.313(a))



DOMESTIC LABELING

1. HMT LABELS (172.400)
2. Additional SubsidiaryHazard (172.402(a)):
   8 (Corrosive)

DANGEROUS GOODS DETERMINATION (38th Edition) IATA

- Air Transport of This Material if Forbidden (Passenger and Cargo)

HYDRAZINE

0281
March 1995

CAS No: 302-01-2
RTECS No: MU7175000
UN No: 2029
EC No: 007-008-00-3

Diamide
Diamine
Nitrogen hydride
(anhydrous)
N_2H_4 / $H_2N\text{-}NH_2$
Molecular mass: 32.1

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Flammable.	NO open flames, NO sparks, and NO smoking.	Powder, alcohol-resistant foam, water spray, carbon dioxide.
EXPLOSION	Above 38•C explosive vapour/air mixtures may be formed. Risk of fire and explosion on contact with many materials.	Above 38•C use a closed system, ventilation, and explosion-proof electrical equipment.	In case of fire: keep drums, etc., cool by spraying with water. Combat fire from a sheltered position.
EXPOSURE		**STRICT HYGIENE!**	**IN ALL CASES CONSULT A DOCTOR!**
Inhalation	Corrosive. Burning sensation. Cough. Headache. Nausea. Shortness of breath. Sore throat. Convulsions.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Refer for medical attention.
Skin	Corrosive. MAY BE ABSORBED! Redness. Skin burns. Pain.	Protective gloves. Protective clothing.	First rinse with plenty of water, then remove contaminated clothes and rinse again. Refer for medical attention. Wear protective gloves when administering first aid.
Eyes	Corrosive. Redness. Pain. Severe deep burns.	Eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Corrosive. Abdominal cramps. Confusion. Convulsions. Unconsciousness. Vomiting. Weakness.	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	PACKAGING & LABELLING	
Evacuate danger area! Consult an expert! Collect leaking liquid in sealable containers. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT absorb in saw-dust or other combustible absorbents. Do NOT let this chemical enter the environment. Personal protection: complete protective clothing including self-contained breathing apparatus.	T Symbol N Symbol R: 45-10-23/24/25-34-43-50/53 S: 53-45-60-61 Note: E UN Hazard Class: 8 UN Subsidiary Risks: 3 and 6.1 UN Pack Group: I	Special material. Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs.

EMERGENCY RESPONSE	SAFE STORAGE
Transport Emergency Card: TEC (R)-80S2029 NFPA Code: H3; F3; R2	Fireproof. Separated from food and feedstuffs. See Chemical Dangers.

IPCS
International
Programme on
Chemical Safety

UNEP

Prepared in the context of cooperation between the International Programme on Chemical Safety and the European Commission © IPCS 2005

SEE IMPORTANT INFORMATION ON THE BACK.

0281 HYDRAZINE

IMPORTANT DATA

Physical State; Appearance
COLOURLESS FUMING AND HYGROSCOPIC LIQUID, WITH PUNGENT ODOUR.

Chemical dangers
The substance decomposes producing ammonia fumes, hydrogen and nitrogen oxides, causing fire and explosion hazard. The substance is a strong reducing agent and reacts violently with oxidants. The substance is a medium strong base. Reacts violently with many metals, metal oxides and porous materials causing fire and explosion hazard. Air or oxygen is not required for decomposition.

Occupational exposure limits
TLV: 0.01 ppm as TWA; (skin); A3 (confirmed animal carcinogen with unknown relevance to humans); (ACGIH 2004).
MAK: skin absorption (H); sensitization of skin (Sh); Carcinogen category: 2; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation of its vapour, through the skin and by ingestion.

Inhalation risk
A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20°C.

Effects of short-term exposure
The substance is corrosive to the eyes and the skin. The vapour of this substance is corrosive to the respiratory tract. Inhalation of the vapour may cause lung oedema (see Notes). The substance may cause effects on the liver kidneys and central nervous system. Exposure may result in death. The effects may be delayed. Medical observation is indicated.

Effects of long-term or repeated exposure
Repeated or prolonged contact may cause skin sensitization. The substance may have effects on the liver, kidneys and central nervous system. This substance is possibly carcinogenic to humans.

PHYSICAL PROPERTIES

Boiling point: 114°C
Melting point: 2°C
Relative density (water = 1): 1.01
Solubility in water: very good
Vapour pressure, kPa at 20°C: 1.4
Relative vapour density (air = 1): 1.1
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.00
Flash point: 38°C c.c.
Auto-ignition temperature: see Notes
Explosive limits, vol% in air: 1.8-100
Octanol/water partition coefficient as log Pow: -3.1

ENVIRONMENTAL DATA

The substance is very toxic to aquatic organisms.

NOTES

Auto-ignition temperature varies from 24•C on a rusty iron surface to 270°C on glass surface.
Depending on the degree of exposure, periodic medical examination is suggested.
The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential.
Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered.
The odour warning when the exposure limit value is exceeded is insufficient.
Rinse contaminated clothes (fire hazard) with plenty of water.
Other UN numbers are: UN 2030 Hydrazine hydrate or Hydrazine, aqueous solutions with 37-64% of hydrazine; UN 3293 Hydrazine, aqueous solutions with not more than 37% of hydrazine.
Card has been partly updated in October 2005. See sections Occupational Exposure Limits, EU classification, Emergency Response.

ADDITIONAL INFORMATION

LEGAL NOTICE	Neither the EC nor the IPCS nor any person acting on behalf of the EC or the IPCS is responsible for the use which might be made of this information

ETHYL ACETATE

0367
October 1997

CAS No: 141-78-6 RTECS No: AH5425000 UN No: 1173 EC No: 607-022-00-5	Acetic acid, ethyl ester Acetic ether $C_4H_8O_2$ / $CH_3COOC_2H_5$ Molecular mass: 88.1

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Highly flammable.	NO open flames, NO sparks, and NO smoking.	AFFF, alcohol-resistant foam, powder, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Use non-sparking handtools.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		**PREVENT GENERATION OF MISTS!**	
Inhalation	Cough. Dizziness. Drowsiness. Headache. Nausea. Sore throat. Unconsciousness. Weakness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration may be needed. Refer for medical attention.
Skin	Dry skin.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
Eyes	Redness. Pain.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion		Do not eat, drink, or smoke during work.	Rinse mouth. Give plenty of water to drink.

SPILLAGE DISPOSAL	PACKAGING & LABELLING
Evacuate danger area! Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer. Personal protection: complete protective clothing including self-contained breathing apparatus.	F Symbol Xi Symbol R: 11-36-66-67 S: (2-)16-26-33 UN Hazard Class: 3 UN Pack Group: II

EMERGENCY RESPONSE	SAFE STORAGE
Transport Emergency Card: TEC (R)-30S1173 NFPA Code: H1; F3; R0	Fireproof. Separated from strong oxidants. Cool. Well closed.

IPCS
International Programme on Chemical Safety

Prepared in the context of cooperation between the International Programme on Chemical Safety and the European Commission © IPCS 2004

SEE IMPORTANT INFORMATION ON THE BACK.

0367 ETHYL ACETATE

IMPORTANT DATA

Physical State; Appearance
COLOURLESS LIQUID, WITH CHARACTERISTIC ODOUR.

Physical dangers
The vapour is heavier than air and may travel along the ground; distant ignition possible.

Chemical dangers
Heating may cause violent combustion or explosion. The substance decomposes under the influence of UV light, acids, bases. Reacts with strong oxidants, bases or acids. Attacks aluminium and plastics.

Occupational exposure limits
TLV: 400 ppm as TWA; (ACGIH 2004).
MAK: 400 ppm, 1500 mg/m^3; Peak limitation category: I(2); Pregnancy risk group: C; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation of its vapour.

Inhalation risk
A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C.

Effects of short-term exposure
The substance is irritating to the eyes and the respiratory tract. The substance may cause effects on the central nervous system. Exposure far above the OEL may result in death.

Effects of long-term or repeated exposure
The liquid defats the skin.

PHYSICAL PROPERTIES

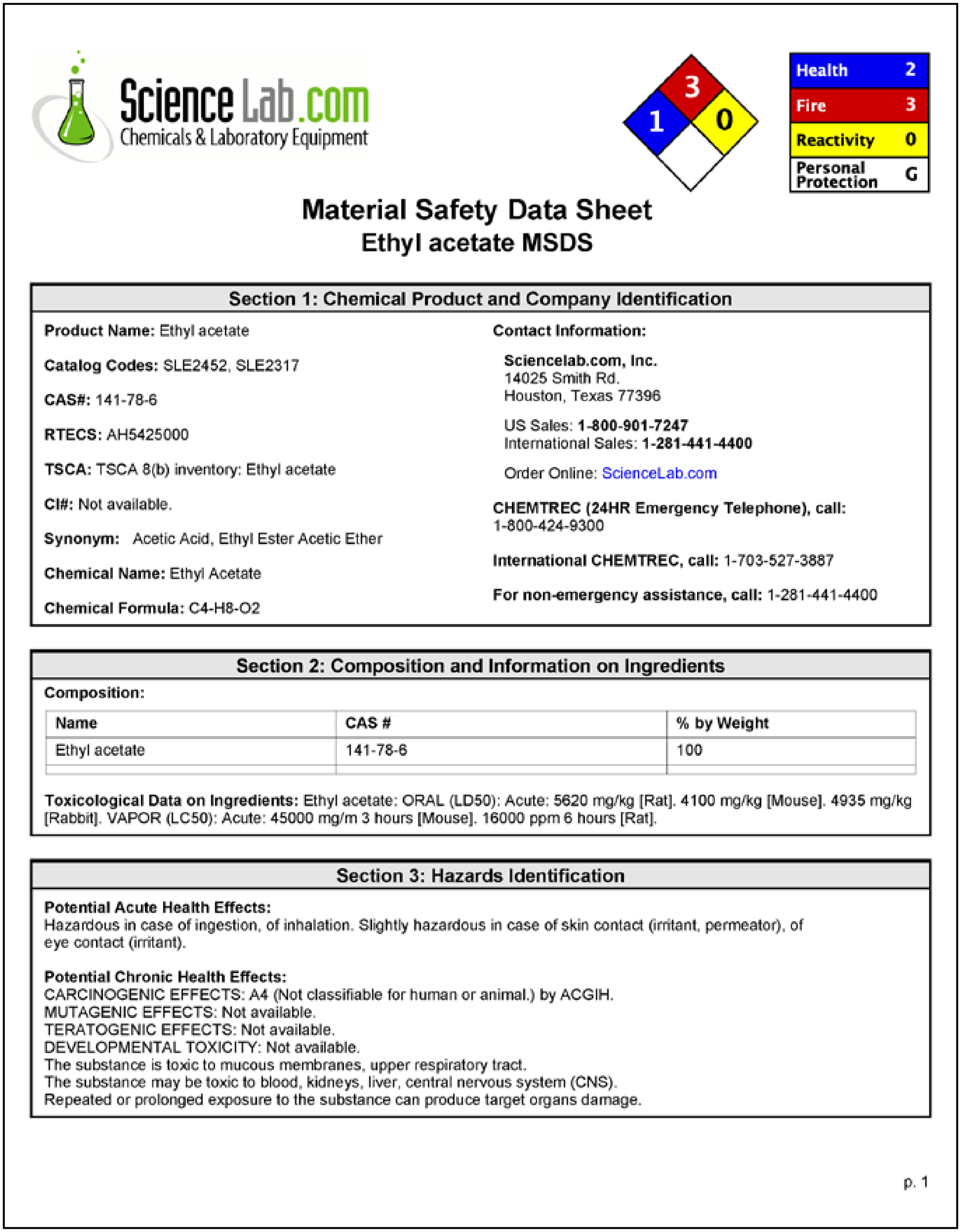
Boiling point: 77°C
Melting point: -84°C
Relative density (water = 1): 0.9
Solubility in water: very good
Vapour pressure, kPa at 20°C: 10
Relative vapour density (air = 1): 3.0
Flash point: -4°C c.c.
Auto-ignition temperature: 427°C
Explosive limits, vol% in air: 2.2-11.5
Octanol/water partition coefficient as log Pow: 0.73

ENVIRONMENTAL DATA

NOTES

Use of alcoholic beverages enhances the harmful effect.
Acetidin, Vinegar naphtha are trade names.
Card has been partly updated in October 2004. See sections Occupational Exposure Limits, EU classification, Emergency Response.

ADDITIONAL INFORMATION



Health	2
Fire	3
Reactivity	0
Personal Protection	G

Material Safety Data Sheet
Ethyl acetate MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethyl acetate

Catalog Codes: SLE2452, SLE2317

CAS#: 141-78-6

RTECS: AH5425000

TSCA: TSCA 8(b) inventory: Ethyl acetate

CI#: Not available.

Synonym: Acetic Acid, Ethyl Ester Acetic Ether

Chemical Name: Ethyl Acetate

Chemical Formula: C4-H8-O2

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

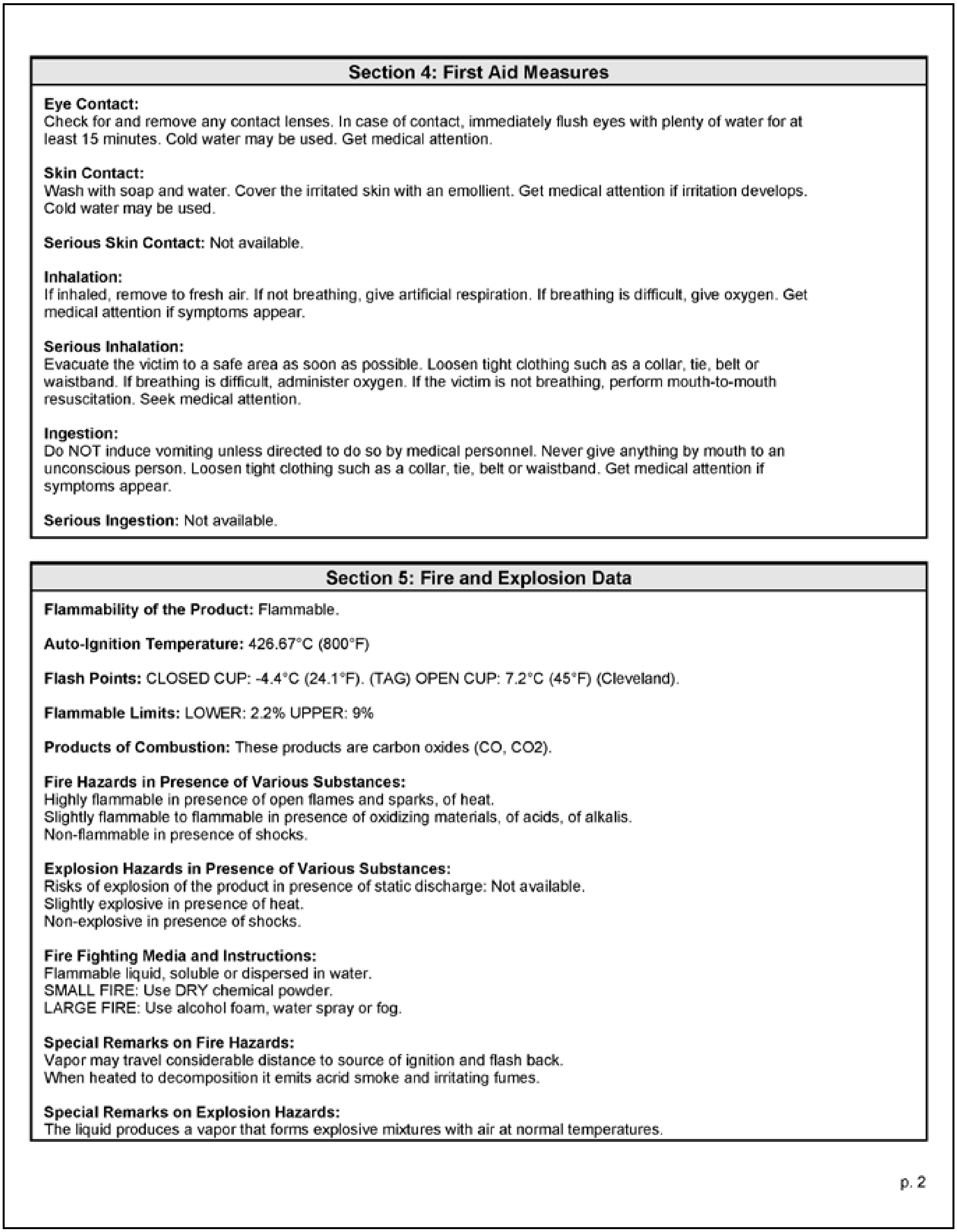
Name	CAS #	% by Weight
Ethyl acetate	141-78-6	100

Toxicological Data on Ingredients: Ethyl acetate: ORAL (LD50): Acute: 5620 mg/kg [Rat]. 4100 mg/kg [Mouse]. 4935 mg/kg [Rabbit]. VAPOR (LC50): Acute: 45000 mg/m 3 hours [Mouse]. 16000 ppm 6 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance is toxic to mucous membranes, upper respiratory tract.
The substance may be toxic to blood, kidneys, liver, central nervous system (CNS).
Repeated or prolonged exposure to the substance can produce target organs damage.



Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 426.67°C (800°F)

Flash Points: CLOSED CUP: -4.4°C (24.1°F). (TAG) OPEN CUP: 7.2°C (45°F) (Cleveland).

Flammable Limits: LOWER: 2.2% UPPER: 9%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Highly flammable in presence of open flames and sparks, of heat.
Slightly flammable to flammable in presence of oxidizing materials, of acids, of alkalis.
Non-flammable in presence of shocks.

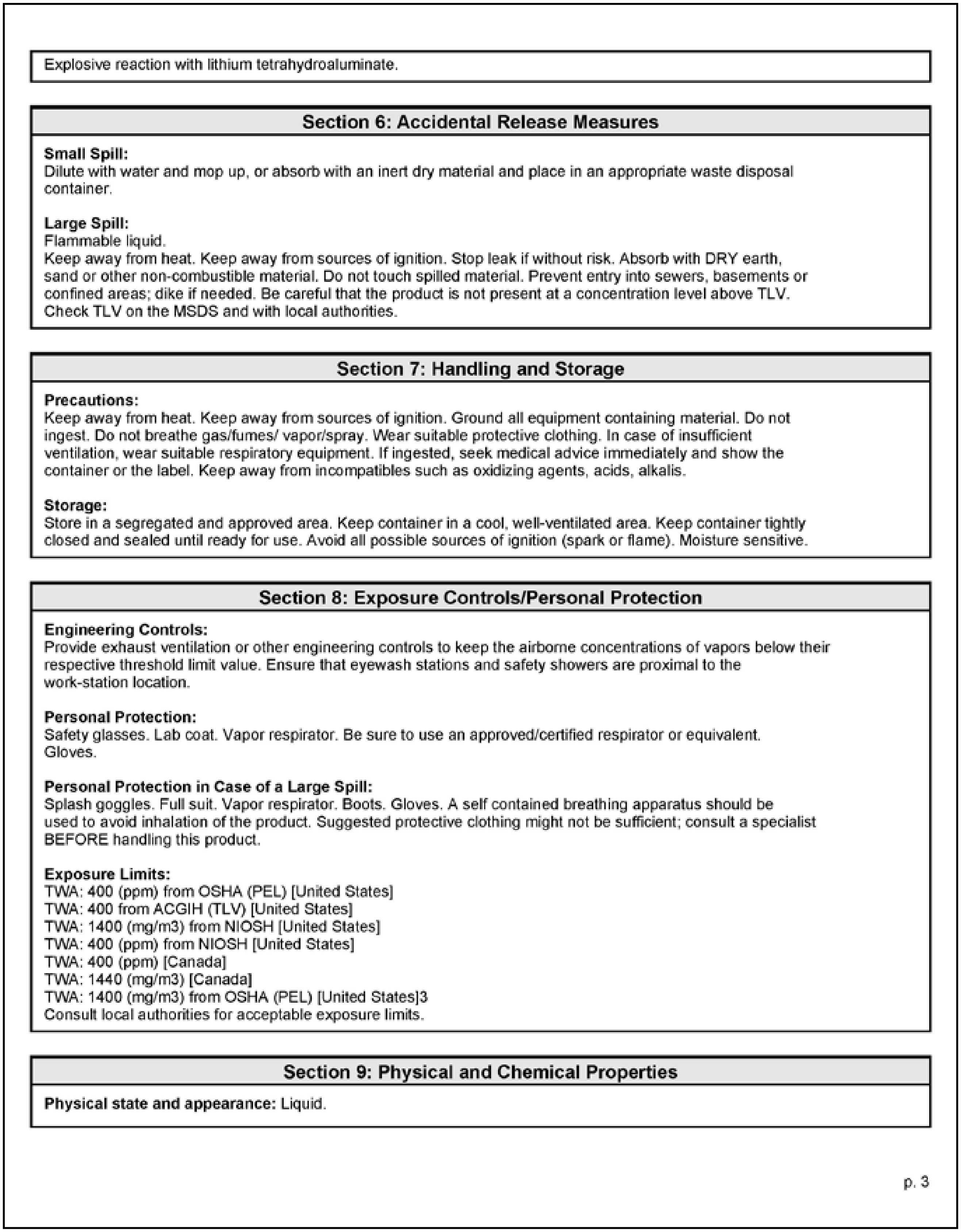
Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of static discharge: Not available.
Slightly explosive in presence of heat.
Non-explosive in presence of shocks.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water.
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:
Vapor may travel considerable distance to source of ignition and flash back.
When heated to decomposition it emits acrid smoke and irritating fumes.

Special Remarks on Explosion Hazards:
The liquid produces a vapor that forms explosive mixtures with air at normal temperatures.

p. 2



Explosive reaction with lithium tetrahydroaluminate.

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.

Large Spill:
Flammable liquid.
Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids, alkalis.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Moisture sensitive.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Safety glasses. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 400 (ppm) from OSHA (PEL) [United States]
TWA: 400 from ACGIH (TLV) [United States]
TWA: 1400 (mg/m3) from NIOSH [United States]
TWA: 400 (ppm) from NIOSH [United States]
TWA: 400 (ppm) [Canada]
TWA: 1440 (mg/m3) [Canada]
TWA: 1400 (mg/m3) from OSHA (PEL) [United States]3
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

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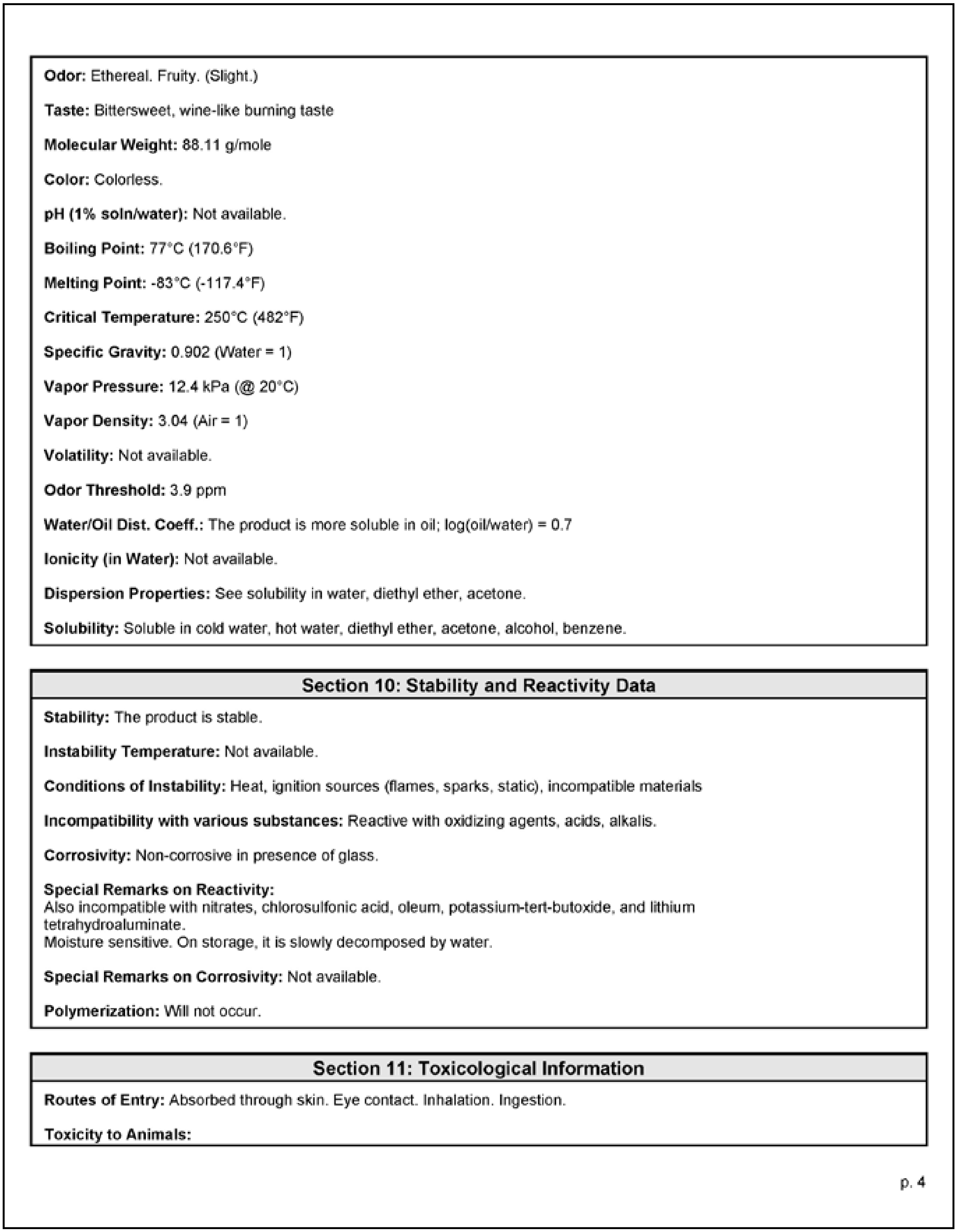


Odor: Ethereal. Fruity. (Slight.)

Taste: Bittersweet, wine-like burning taste

Molecular Weight: 88.11 g/mole

Color: Colorless.

pH (1% soln/water): Not available.

Boiling Point: 77°C (170.6°F)

Melting Point: -83°C (-117.4°F)

Critical Temperature: 250°C (482°F)

Specific Gravity: 0.902 (Water = 1)

Vapor Pressure: 12.4 kPa (@ 20°C)

Vapor Density: 3.04 (Air = 1)

Volatility: Not available.

Odor Threshold: 3.9 ppm

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 0.7

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether, acetone.

Solubility: Soluble in cold water, hot water, diethyl ether, acetone, alcohol, benzene.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, ignition sources (flames, sparks, static), incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, acids, alkalis.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Also incompatible with nitrates, chlorosulfonic acid, oleum, potassium-tert-butoxide, and lithium tetrahydroaluminate.
Moisture sensitive. On storage, it is slowly decomposed by water.

Special Remarks on Corrosivity: Not available.

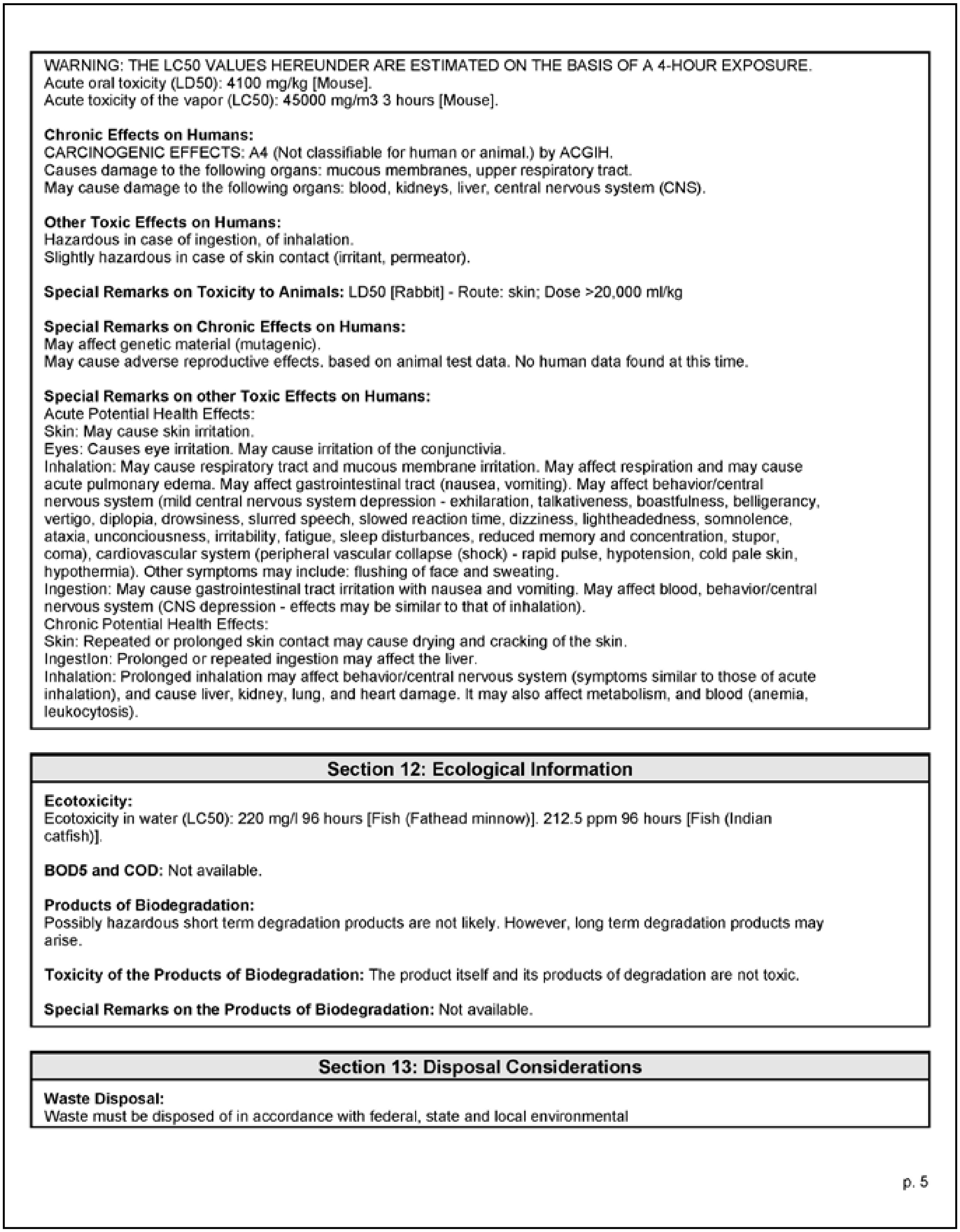
Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:

p. 4



WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE.
Acute oral toxicity (LD50): 4100 mg/kg [Mouse].
Acute toxicity of the vapor (LC50): 45000 mg/m3 3 hours [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
Causes damage to the following organs: mucous membranes, upper respiratory tract.
May cause damage to the following organs: blood, kidneys, liver, central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of ingestion, of inhalation.
Slightly hazardous in case of skin contact (irritant, permeator).

Special Remarks on Toxicity to Animals: LD50 [Rabbit] - Route: skin; Dose >20,000 ml/kg

Special Remarks on Chronic Effects on Humans:
May affect genetic material (mutagenic).
May cause adverse reproductive effects. based on animal test data. No human data found at this time.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: May cause skin irritation.
Eyes: Causes eye irritation. May cause irritation of the conjunctivia.
Inhalation: May cause respiratory tract and mucous membrane irritation. May affect respiration and may cause acute pulmonary edema. May affect gastrointestinal tract (nausea, vomiting). May affect behavior/central nervous system (mild central nervous system depression - exhilaration, talkativeness, boastfulness, belligerancy, vertigo, diplopia, drowsiness, slurred speech, slowed reaction time, dizziness, lightheadedness, somnolence, ataxia, unconciousness, irritability, fatigue, sleep disturbances, reduced memory and concentration, stupor, coma), cardiovascular system (peripheral vascular collapse (shock) - rapid pulse, hypotension, cold pale skin, hypothermia). Other symptoms may include: flushing of face and sweating.
Ingestion: May cause gastrointestinal tract irritation with nausea and vomiting. May affect blood, behavior/central nervous system (CNS depression - effects may be similar to that of inhalation).
Chronic Potential Health Effects:
Skin: Repeated or prolonged skin contact may cause drying and cracking of the skin.
Ingestion: Prolonged or repeated ingestion may affect the liver.
Inhalation: Prolonged inhalation may affect behavior/central nervous system (symptoms similar to those of acute inhalation), and cause liver, kidney, lung, and heart damage. It may also affect metabolism, and blood (anemia, leukocytosis).

Section 12: Ecological Information

Ecotoxicity:
Ecotoxicity in water (LC50): 220 mg/l 96 hours [Fish (Fathead minnow)]. 212.5 ppm 96 hours [Fish (Indian catfish)].

BOD5 and COD: Not available.

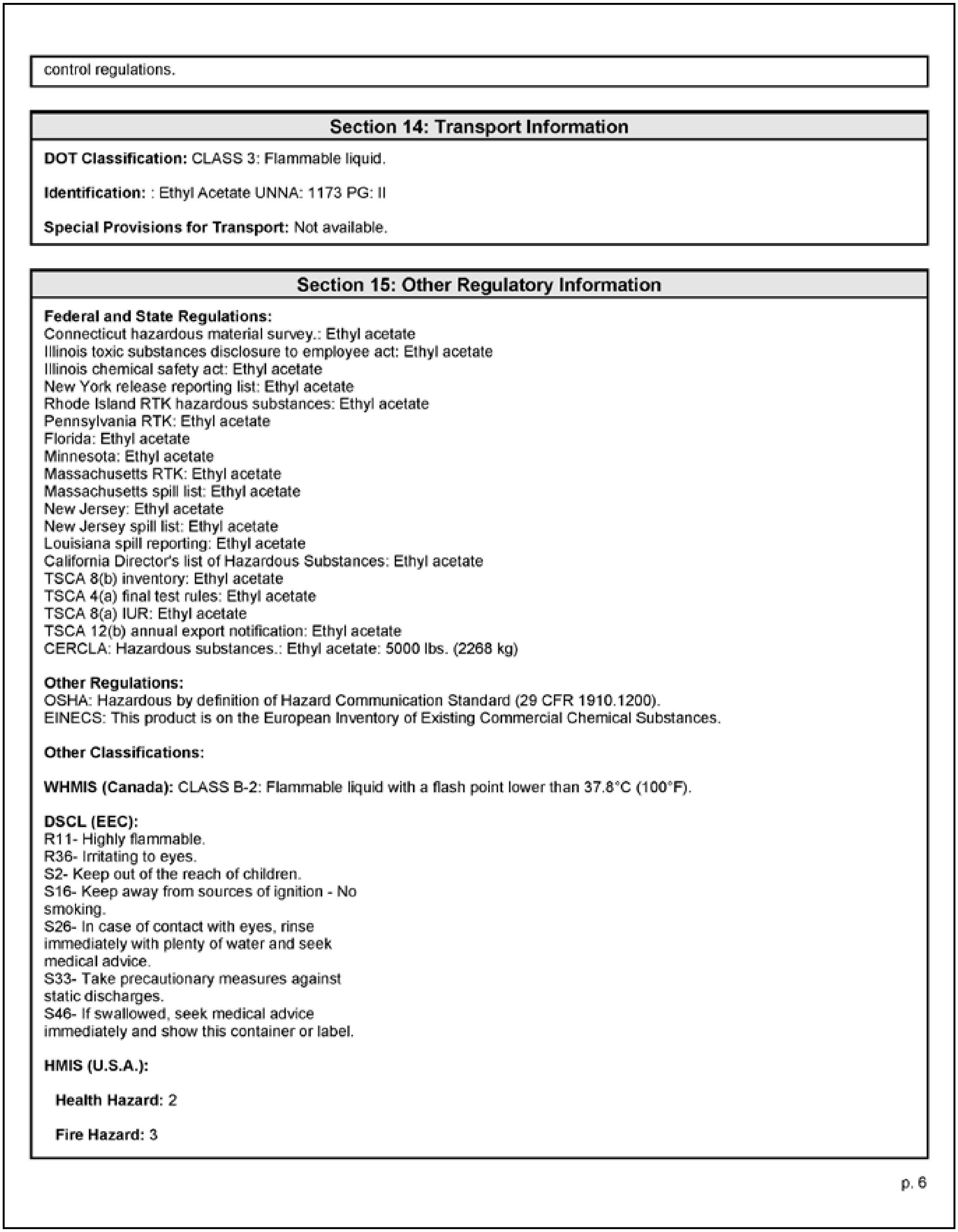
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental



control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Ethyl Acetate UNNA: 1173 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Ethyl acetate
Illinois toxic substances disclosure to employee act: Ethyl acetate
Illinois chemical safety act: Ethyl acetate
New York release reporting list: Ethyl acetate
Rhode Island RTK hazardous substances: Ethyl acetate
Pennsylvania RTK: Ethyl acetate
Florida: Ethyl acetate
Minnesota: Ethyl acetate
Massachusetts RTK: Ethyl acetate
Massachusetts spill list: Ethyl acetate
New Jersey: Ethyl acetate
New Jersey spill list: Ethyl acetate
Louisiana spill reporting: Ethyl acetate
California Director's list of Hazardous Substances: Ethyl acetate
TSCA 8(b) inventory: Ethyl acetate
TSCA 4(a) final test rules: Ethyl acetate
TSCA 8(a) IUR: Ethyl acetate
TSCA 12(b) annual export notification: Ethyl acetate
CERCLA: Hazardous substances.: Ethyl acetate: 5000 lbs. (2268 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

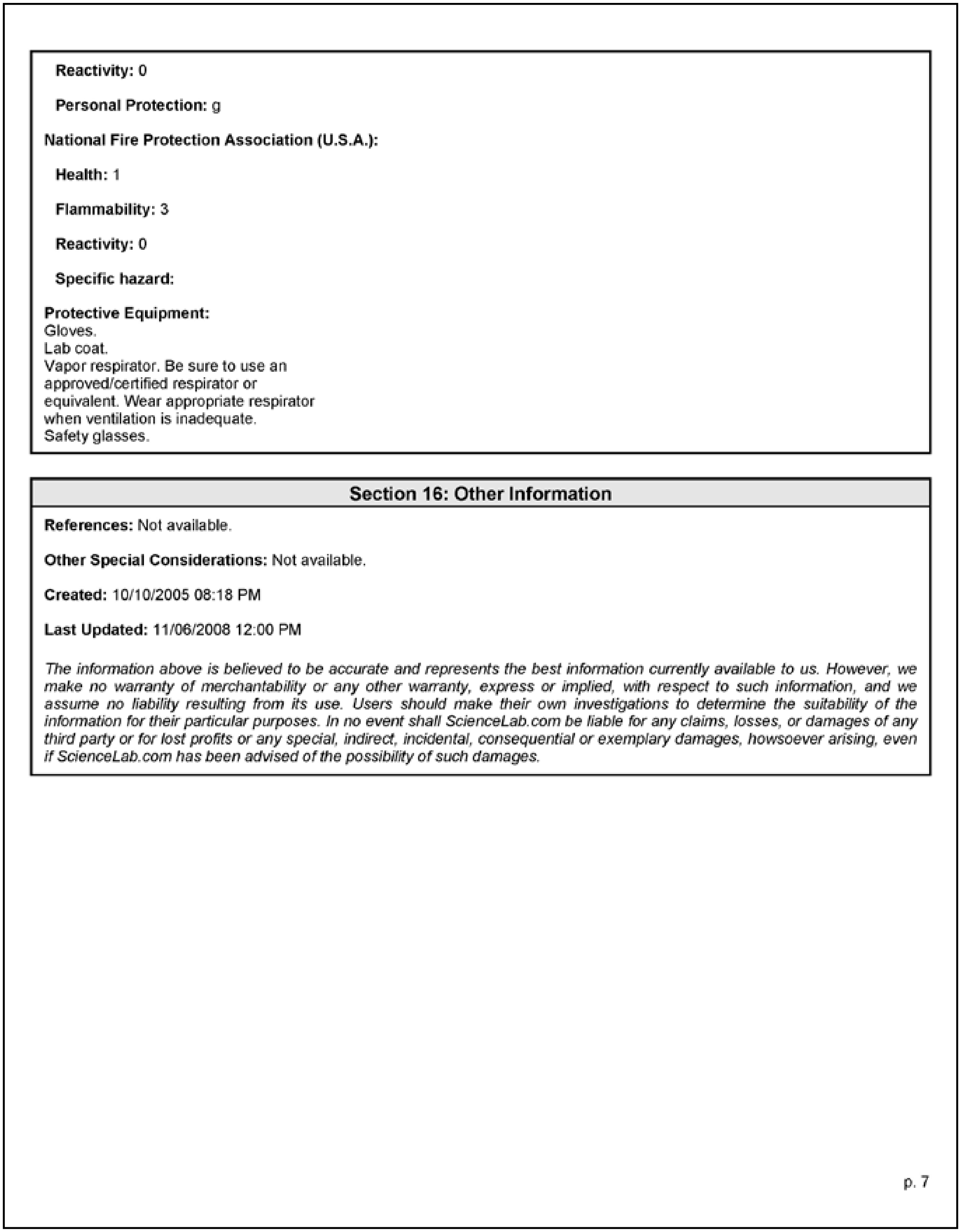
WHMIS (Canada): CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F).

DSCL (EEC):
R11- Highly flammable.
R36- Irritating to eyes.
S2- Keep out of the reach of children.
S16- Keep away from sources of ignition - No smoking.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S33- Take precautionary measures against static discharges.
S46- If swallowed, seek medical advice immediately and show this container or label.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3



Reactivity: 0

Personal Protection: g

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Safety glasses.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:18 PM

Last Updated: 11/06/2008 12:00 PM

HYDROGEN CHLORIDE

0163
April 2000

CAS No: 7647-01-0 RTECS No: MW4025000 UN No: 1050 EC No: 017-002-00-2	Anhydrous hydrogen chloride Hydrochloric acid, anhydrous (cylinder) HCl Molecular mass: 36.5

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Not combustible.		In case of fire in the surroundings: use appropriate extinguishing media.
EXPLOSION			In case of fire: keep cylinder cool by spraying with water.
EXPOSURE		**AVOID ALL CONTACT!**	**IN ALL CASES CONSULT A DOCTOR!**
Inhalation	Corrosive. Burning sensation. Cough. Laboured breathing. Shortness of breath. Sore throat. Symptoms may be delayed (see Notes).	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
Skin	ON CONTACT WITH LIQUID: FROSTBITE. Corrosive. Serious skin burns. Pain.	Cold-insulating gloves. Protective clothing.	First rinse with plenty of water, then remove contaminated clothes and rinse again. Refer for medical attention.
Eyes	Corrosive. Pain. Blurred vision. Severe deep burns.	Safety goggles or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion			

SPILLAGE DISPOSAL	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Ventilation. Remove gas with fine water spray. Personal protection: complete protective clothing including self-contained breathing apparatus.	T Symbol C Symbol R: 23-35 S: (1/2-)9-26-36/37/39-45 UN Hazard Class: 2.3 UN Subsidiary Risks: 8

EMERGENCY RESPONSE	SAFE STORAGE
Transport Emergency Card: TEC (R)-20S1050 NFPA Code: H 3; F 0; R 1	Separated from combustible and reducing substances, strong oxidants, strong bases, metals. Keep in a well-ventilated room. Cool. Dry.

IPCS
International
Programme on
Chemical Safety

UNEP

SEE IMPORTANT INFORMATION ON THE BACK.

0163 HYDROGEN CHLORIDE

IMPORTANT DATA

Physical State; Appearance
COLOURLESS COMPRESSED LIQUEFIED GAS, WITH PUNGENT ODOUR.

Physical dangers
The gas is heavier than air.

Chemical dangers
The solution in water is a strong acid, it reacts violently with bases and is corrosive. Reacts violently with oxidants forming toxic gas (chlorine - see ICSC 0126). Attacks many metals in the presence of water forming flammable/explosive gas (hydrogen - see ICSC0001).

Occupational exposure limits
TLV: 2 ppm; (Ceiling value); A4 (not classifiable as a human carcinogen); (ACGIH 2004).
MAK: 2 ppm, 3.0 mg/m^3; Peak limitation category: I(2); Pregnancy risk group: C; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation.

Inhalation risk
A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

Effects of short-term exposure
Rapid evaporation of the liquid may cause frostbite. The substance is corrosive to the eyes, the skin and the respiratory tract. Inhalation of high concentrations of the gas may cause pneumonitis and lung oedema, resulting in reactive airways dysfunction syndrome (RADS) (see Notes). The effects may be delayed. Medical observation is indicated.

Effects of long-term or repeated exposure
The substance may have effects on the lungs, resulting in chronic bronchitis. The substance may have effects on the teeth, resulting in erosion.

PHYSICAL PROPERTIES

Boiling point: -85°C
Melting point: -114°C
Density: 1.00045 g/l (gas)
Solubility in water, g/100 ml at 30°C: 67
Relative vapour density (air = 1): 1.3
Octanol/water partition coefficient as log Pow: 0.25

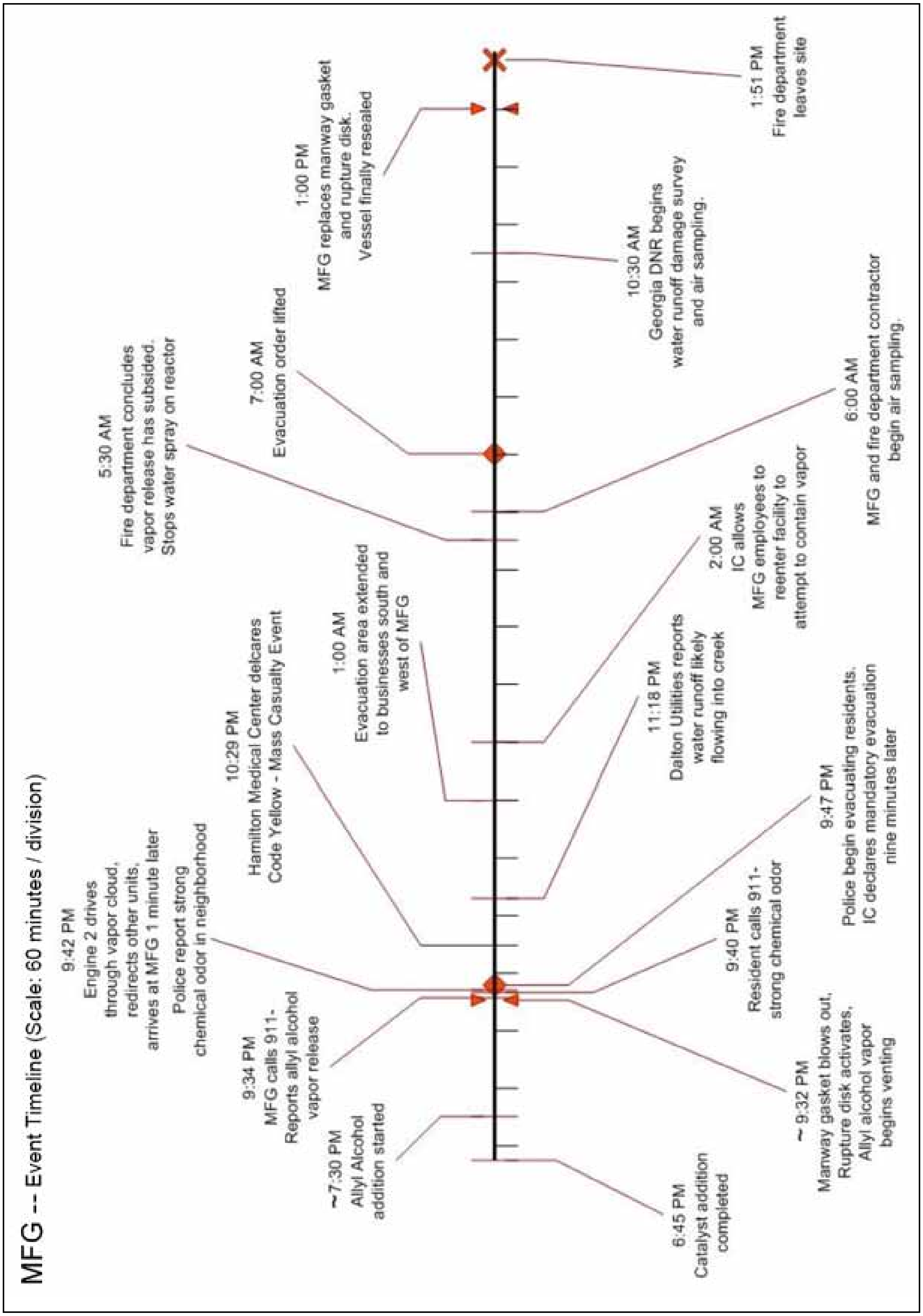
ENVIRONMENTAL DATA

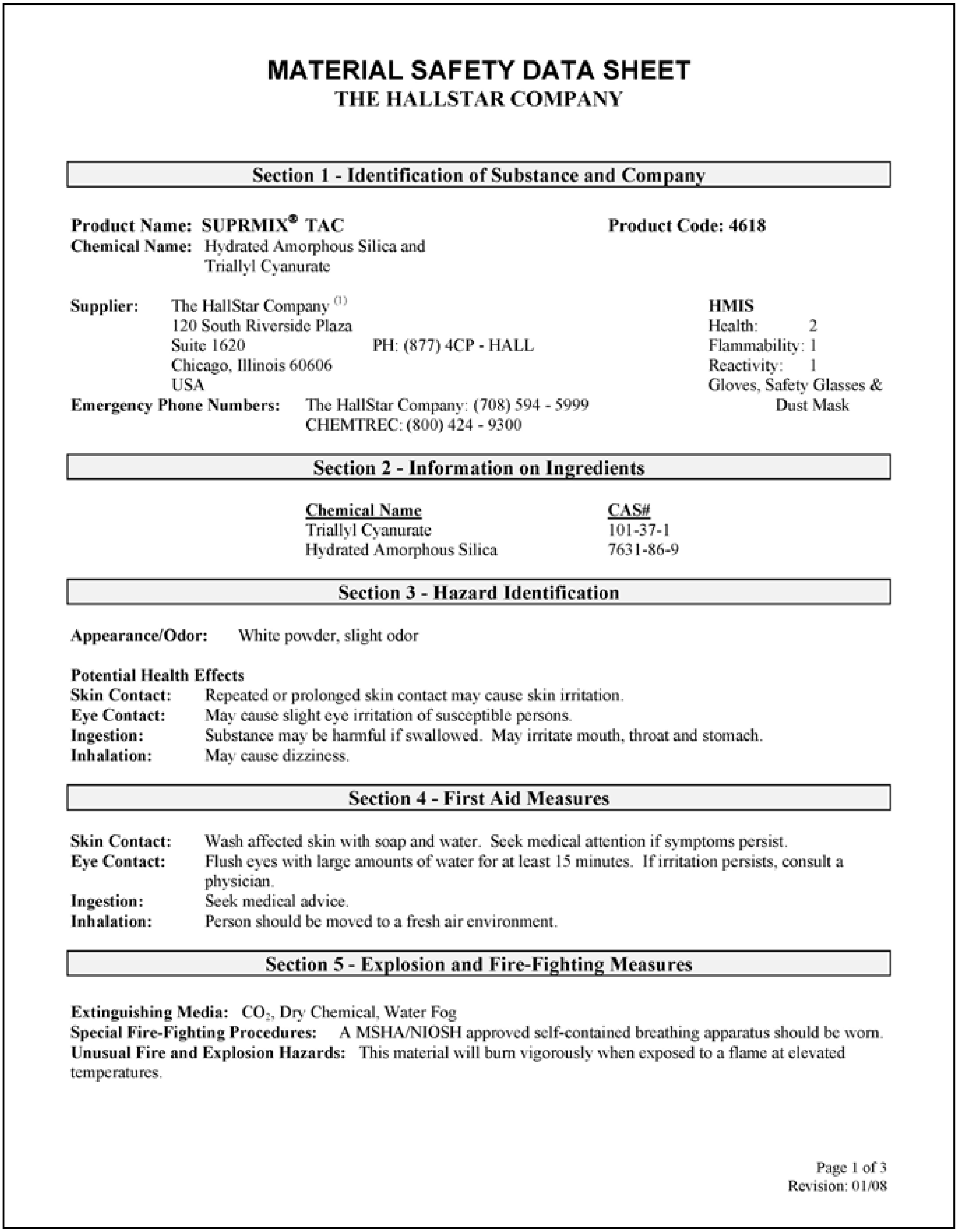
NOTES

The applying occupational exposure limit value should not be exceeded during any part of the working exposure.
The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential.
Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered.
Do NOT spray water on leaking cylinder (to prevent corrosion of cylinder).
Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.
Other UN numbers: 2186 (refridgerated liquid) hazard class: 2.3; subsidiary hazard: 8; 1789 (hydrochloric acid) hazard class: 8, pack group II or III. Aqueous solutions may contain up to 38% hydrogen chloride.
Card has been partly updated in April 2005. See sections Occupational Exposure Limits, Emergency Response.

ADDITIONAL INFORMATION

LEGAL NOTICE	Neither the EC nor the IPCS nor any person acting on behalf of the EC or the IPCS is responsible


MFG -- Event Timeline (Scale: 60 minutes / division)
6:45 PM
Catalyst addition completed
~7:30 PM
Allyl Alcohol addition started
~ 9:32 PM
Manway gasket blows out, Rupture disk activates, Allyl alcohol vapor begins venting
9:34 PM
MFG calls 911- Reports allyl alcohol vapor release
9:40 PM
Resident calls 911- strong chemical odor
9:42 PM
Engine 2 drives through vapor cloud, redirects other units, arrives at MFG 1 minute later
Police report strong chemical odor in neighborhood
9:47 PM
Police begin evacuating residents. IC declares mandatory evacuation nine minutes later
10:29 PM
Hamilton Medical Center delcares Code Yellow - Mass Casualty Event
11:18 PM
Dalton Utilities reports water runoff likely flowing into creek
1:00 AM
Evacuation area extended to businesses south and west of MFG
2:00 AM
IC allows MFG employees to reenter facility to attempt to contain vapor
5:30 AM
Fire department concludes vapor release has subsided. Stops water spray on reactor
6:00 AM
MFG and fire department contractor begin air sampling.
7:00 AM
Evacuation order lifted
10:30 AM
Georgia DNR begins water runoff damage survey and air sampling.
1:00 PM
MFG replaces manway gasket and rupture disk. Vessel finally resealed
1:51 PM
Fire department leaves site



MATERIAL SAFETY DATA SHEET

THE HALLSTAR COMPANY

Section 1 - Identification of Substance and Company

Product Name: **SUPRMIX® TAC** **Product Code: 4618**
Chemical Name: Hydrated Amorphous Silica and
Triallyl Cyanurate

Supplier: The HallStar Company (1)
120 South Riverside Plaza
Suite 1620 PH: (877) 4CP - HALL
Chicago, Illinois 60606
USA
Emergency Phone Numbers: The HallStar Company: (708) 594 - 5999
CHEMTREC: (800) 424 - 9300

HMIS
Health: 2
Flammability: 1
Reactivity: 1
Gloves, Safety Glasses &
Dust Mask

Section 2 - Information on Ingredients

Chemical Name	CAS#
Triallyl Cyanurate	101-37-1
Hydrated Amorphous Silica	7631-86-9

Section 3 - Hazard Identification

Appearance/Odor: White powder, slight odor

Potential Health Effects
Skin Contact: Repeated or prolonged skin contact may cause skin irritation.
Eye Contact: May cause slight eye irritation of susceptible persons.
Ingestion: Substance may be harmful if swallowed. May irritate mouth, throat and stomach.
Inhalation: May cause dizziness.

Section 4 - First Aid Measures

Skin Contact: Wash affected skin with soap and water. Seek medical attention if symptoms persist.
Eye Contact: Flush eyes with large amounts of water for at least 15 minutes. If irritation persists, consult a physician.
Ingestion: Seek medical advice.
Inhalation: Person should be moved to a fresh air environment.

Section 5 - Explosion and Fire-Fighting Measures

Extinguishing Media: CO_2, Dry Chemical, Water Fog
Special Fire-Fighting Procedures: A MSHA/NIOSH approved self-contained breathing apparatus should be worn.
Unusual Fire and Explosion Hazards: This material will burn vigorously when exposed to a flame at elevated temperatures.

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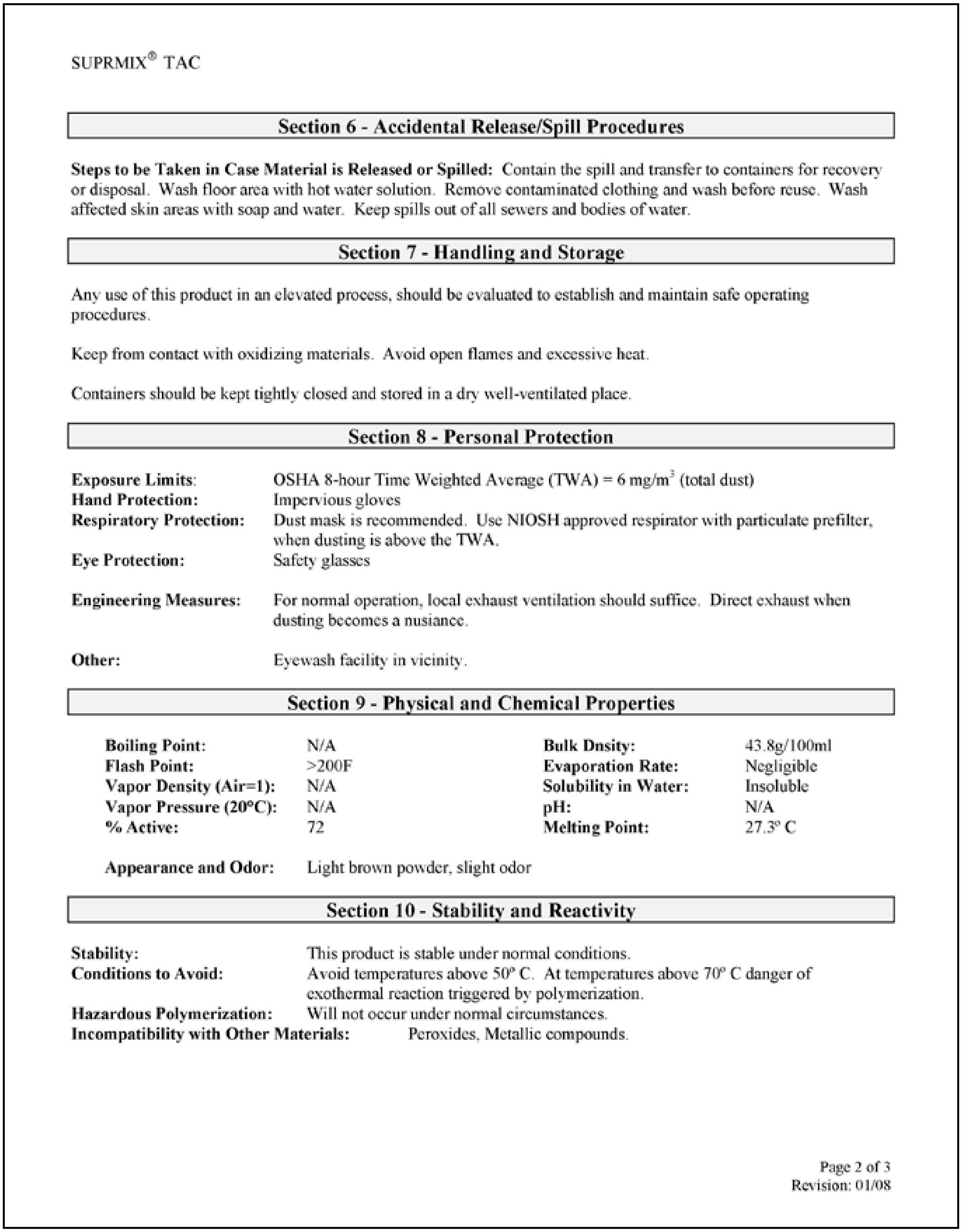
Revision: 01/08



SUPRMIX® TAC

Section 6 - Accidental Release/Spill Procedures

Steps to be Taken in Case Material is Released or Spilled: Contain the spill and transfer to containers for recovery or disposal. Wash floor area with hot water solution. Remove contaminated clothing and wash before reuse. Wash affected skin areas with soap and water. Keep spills out of all sewers and bodies of water.

Section 7 - Handling and Storage

Any use of this product in an elevated process, should be evaluated to establish and maintain safe operating procedures.

Keep from contact with oxidizing materials. Avoid open flames and excessive heat.

Containers should be kept tightly closed and stored in a dry well-ventilated place.

Section 8 - Personal Protection

Exposure Limits:	OSHA 8-hour Time Weighted Average (TWA) = 6 mg/m^3 (total dust)
Hand Protection:	Impervious gloves
Respiratory Protection:	Dust mask is recommended. Use NIOSH approved respirator with particulate prefilter, when dusting is above the TWA.
Eye Protection:	Safety glasses
Engineering Measures:	For normal operation, local exhaust ventilation should suffice. Direct exhaust when dusting becomes a nusiance.
Other:	Eyewash facility in vicinity.

Section 9 - Physical and Chemical Properties

Boiling Point:	N/A	**Bulk Dnsity:**	43.8g/100ml
Flash Point:	>200F	**Evaporation Rate:**	Negligible
Vapor Density (Air=1):	N/A	**Solubility in Water:**	Insoluble
Vapor Pressure (20°C):	N/A	**pH:**	N/A
% Active:	72	**Melting Point:**	27.3° C

Appearance and Odor: Light brown powder, slight odor

Section 10 - Stability and Reactivity

Stability:	This product is stable under normal conditions.
Conditions to Avoid:	Avoid temperatures above 50° C. At temperatures above 70° C danger of exothermal reaction triggered by polymerization.
Hazardous Polymerization:	Will not occur under normal circumstances.
Incompatibility with Other Materials:	Peroxides, Metallic compounds.

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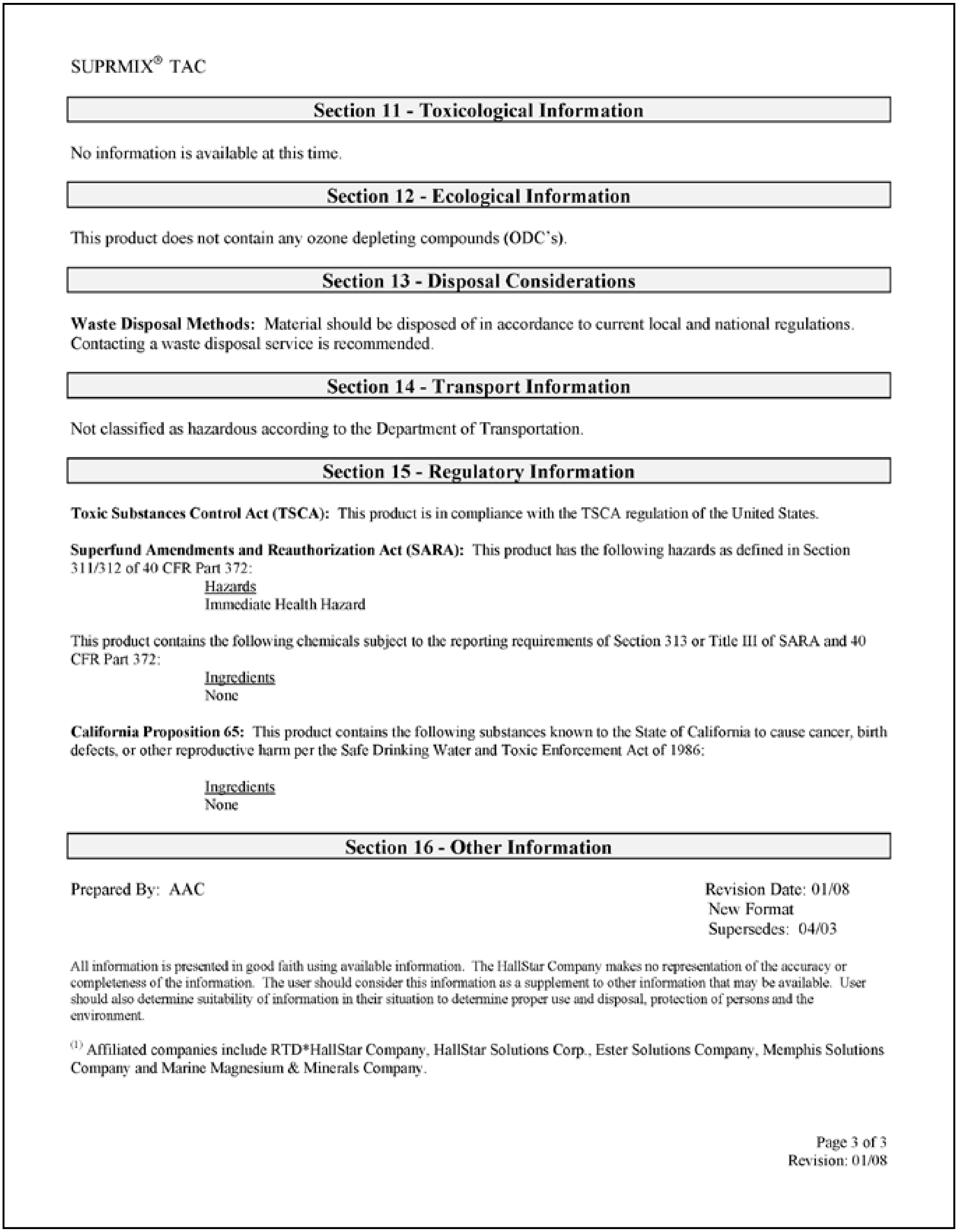
Revision: 01/08



SUPRMIX® TAC

Section 11 - Toxicological Information

No information is available at this time.

Section 12 - Ecological Information

This product does not contain any ozone depleting compounds (ODC's).

Section 13 - Disposal Considerations

Waste Disposal Methods: Material should be disposed of in accordance to current local and national regulations. Contacting a waste disposal service is recommended.

Section 14 - Transport Information

Not classified as hazardous according to the Department of Transportation.

Section 15 - Regulatory Information

Toxic Substances Control Act (TSCA): This product is in compliance with the TSCA regulation of the United States.

Superfund Amendments and Reauthorization Act (SARA): This product has the following hazards as defined in Section 311/312 of 40 CFR Part 372:

Hazards
Immediate Health Hazard

This product contains the following chemicals subject to the reporting requirements of Section 313 or Title III of SARA and 40 CFR Part 372:

Ingredients
None

California Proposition 65: This product contains the following substances known to the State of California to cause cancer, birth defects, or other reproductive harm per the Safe Drinking Water and Toxic Enforcement Act of 1986:

Ingredients
None

Section 16 - Other Information

Prepared By: AAC

Revision Date: 01/08
New Format
Supersedes: 04/03

All information is presented in good faith using available information. The HallStar Company makes no representation of the accuracy or completeness of the information. The user should consider this information as a supplement to other information that may be available. User should also determine suitability of information in their situation to determine proper use and disposal, protection of persons and the environment.

(1) Affiliated companies include RTD*HallStar Company, HallStar Solutions Corp., Ester Solutions Company, Memphis Solutions Company and Marine Magnesium & Minerals Company.

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Revision: 01/08

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Appendix B: Glossary

General Chemical Process Industry Terms

Absorption: The process of absorbing or picking up a liquid hazardous substance or chemical.

Acute Exposure Guideline Levels (AEGLs): Threshold exposure limits for the general public that are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. Three levels AEGL-1, AEGL-2 and AEGL-3 are developed for each of five exposure periods (10 and 30 minutes, 1 hour, 4 hours and 8 hours) and are distinguished by varying degrees of severity of toxic effects; see AEGL-1, AEGL-2 and AEGL-3.

Adsorption: The binding of molecules or particles of a substance or chemical to a surface.

Alcohol-resistant foam: A foam that is resistant to polar chemicals such as ketones and esters which may break down other types of foam.

BLEVE: Boiling liquid, expanding vapor explosions.

Burn: Can refer to either a chemical or thermal burn; the former may be caused by corrosive substances and the latter by liquefied cryogenic gases, hot molten substances or flames.

CO_2: Carbon dioxide gas.

Cold zone: Area where the command post and support functions that are necessary to control the incident are located. It is also referred to as the clean zone, green zone or support zone in other documents. (EPA Standard Operating Safety Guidelines, 29 CFR 1910.120, NFPA® 472)

Combustible liquid: Liquids that have a flash point greater than 141°F (60.5°C) and less than 200°F (93°C). United States regulations permit a flammable liquid with a flash point between 100°F (38°C) and 141°F (60.5°C) to be reclassified as a combustible liquid.

Control zones: Designated areas at chemical process industry incidents, based on safety and the degree of hazard. Many terms are used to describe control zones including hot/exclusion/red/restricted zone, warm/contamination reduction/yellow/limited access zone, and cold/support/green/clean zone. (EPA Standard Operating Safety Guidelines, 29 CFR 1910.120, NFPA® 472)

Cryogenic liquid: A refrigerated, liquefied gas that has a boiling point colder than -130°F (-90°C) at atmospheric pressure (refrigerated liquid).

Dangerous Water-Reactive Material (DWRM): Produces considerable toxic gas when it comes in contact with water.

Decomposition products: Products of a chemical or thermal breakdown of a substance.

Decontamination: The process of removal of dangerous goods from personnel and equipment to the extent necessary to prevent potential adverse health effects.

Dry chemical: A preparation designed for fighting fires involving flammable liquids, pyrophoric substances and electrical equipment. Common dry chemicals contain sodium bicarbonate or potassium bicarbonate.

Edema: The accumulation of an excessive amount of watery fluid in cells and tissues. For example, pulmonary edema is an excessive buildup of water in the lungs after inhalation of a gas that is corrosive to lung tissue.

Extremely Hazardous Substances (EHS): At present, the EPA maintains a list of 366 chemicals that are considered extremely hazardous or acutely toxic. This list was developed under the Superfund Amendments and Reauthorization Act. For each chemical on the list, EPA provides a profile containing chemical identity, synonyms, chemical formula, molecular weight, regulatory information, characteristics, health hazard data, fire and explosion hazard data, reactivity, precautions for safe handling, emergency protective equipment and emergency treatment information.

Emergency Response Plan (ERP): A plan that establishes guidelines for handling hazmat incidents as required by regulations set forth by SARA, Title III and 29 CFR 1910.120.

Emergency Response Planning Guidelines (ERPGs): Estimates of the concentrations at which most people will begin to experience health effects if they are exposed to a toxic chemical for one hour. Chemicals may have up to three ERPG values, each of which corresponds to a specific tier of health effects; see ERPG-1, ERPG-2 and ERPG-3.

ERPG-1: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects, or without perceiving a clearly defined objectionable odor.

ERPG-2: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual’s ability to take protective action.

ERPG-3: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Flammable gas: A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume regardless of the lower limit (as defined in 29 CFR 1910.1200, Hazard Communications).

Flammable liquid: A liquid that has a flash point of 60.5°C (141°F) or lower. (ERG definition)

Flammable liquid: Any liquid having a flash point below 100°F, except any mixture having components with flash points of 100°F or higher, the total of which makes up 99 percent or more of the total volume of the mixture (as defined in 29 CFR 1910.1200, Hazard Communications).

Fog spray: Method or way to apply or distribute water. The water is finely divided to provide for high heat absorption. This method can be used to absorb vapors, knock down vapors or disperse vapors. Direct a water spray, rather than a straight (solid) stream, into the vapor cloud to accomplish any of the above.

Flash point: The lowest temperature at which a liquid or solid gives off vapor in such a concentration that, when the vapor combines with air near the surface of the liquid or solid, a flammable mixture is formed (the lower the flash point, the more flammable the material).

Highly Hazardous Chemicals (HHC): 29 CFR 1910.119 Process Safety Management of Highly Hazardous Chemicals includes a listing of toxic and reactive highly hazardous chemicals which present a potential for a catastrophic event at or above the threshold quantity.

Hot zone: Area immediately surrounding a chemical process industry incident which extends far enough to prevent adverse effects from released hazardous chemicals to personnel outside the zone. This zone can also be referred to as exclusion zone, red zone or restricted zone in other sources. (EPA Standard Operating Safety Guidelines, 29 CFR 1910.120, NFPA® 472)

Immediately Dangerous to Life or Health (IDLH): Defined by NIOSH as exposure to airborne contaminants that is likely to cause death or immediate or delayed permanent adverse health effects, or prevent escape from such an environment. IDLH is commonly used to guide the selection of breathing apparatus for response personnel in specific situations.

Immiscible: A material does not mix readily with water (non-polar).

Ionization Potential (IP): The energy required to completely remove an electron from its atom. It is measured in electron volts (eV). Ionization potentials are given as a guideline for the selection of photo ionization detector lamps used in some direct-reading instruments.

LC50 (Lethal Concentration 50): The concentration of a material administered by inhalation that is expected to cause the death of 50% of an experimental animal population within a specified time. Concentration is reported in either ppm or mg/m^3.

Mass explosion: An explosion which affects almost the entire load virtually instantaneously.

Miscible: A material mixes readily with water (polar).

Noxious: A material that may be harmful or injurious to health or physical well-being.

Oxidizer: A chemical which supplies its own oxygen and which helps other combustible material burn more readily.

P: The letter P identifies a material which may polymerize violently under high temperature conditions or contamination with other products. This polymerization will produce heat and high pressure buildup in containers which may explode or rupture.

Permissible Exposure Limit (PEL): OSHA sets enforceable PELs to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air based on an eight-hour time weighted average (TWA) exposure. PELs may also contain a skin designation.

pH: A value that represents the acidity or alkalinity of a water solution. Pure water has a pH of 7. A pH value below 7 indicates an acid solution while a pH above 7 indicates an alkaline solution. Acids and bases (alkalis) are commonly referred to as corrosive materials.

Poison Inhalation Hazard (PIH): Term used to describe gases and volatile liquids that are toxic when inhaled (same as TIH).

Polymerization: A chemical reaction generally associated with the production of plastic substances. Basically, the individual molecules of the chemical (liquid or gas) react with each other to produce what can be described as a long chain. These chains can be formed in many useful applications. A well known example is the styrofoam (polystyrene) coffee cup which is formed when liquid molecules of styrene react with each other or polymerize, forming a solid and changing the name from styrene to polystyrene (poly means many).

PPE (Personal Protective Equipment) Levels: Levels of protection assigned to combinations of PPE.

Level A: SCBA plus totally encapsulating chemical resistant clothing (permeation resistant)
Level B: SCBA plus hooded chemical resistant clothing (splash suit)
Level C: Full or half-face respirator plus hooded chemical resistant clothing (splash suit)
Level D: Coverall with no respiratory protection

Pyrophoric: A material which ignites spontaneously upon exposure to air (or oxygen). Various pyrophoric materials are also water reactive, reacting strongly with water or high humidity, often igniting upon contact.

Radioactivity: The property of some substances to emit invisible and potentially harmful radiation.

Recommended Exposure Limit (REL): An exposure limit based on animal and human studies recommended by NIOSH scientists to OSHA (also called NIOSH RELs). RELs are scientific recommendations rather than legal standards.

RELs can be defined in up to three ways:

- A time-weighted average (TWA) concentration that NIOSH recommends not be exceeded for up to a 10-hour workday during a 40-hour workweek.
- A ceiling value that NIOSH recommends not be exceeded at any time during the workday (unless noted otherwise).
- A short-term exposure limit (STEL) value that NIOSH recommends not be exceeded for longer than 15 minutes during a workday (unless noted otherwise).

RgasD: Relative Density of Gases referenced to air = 1; indicates how many times a gas is heavier than air at the same temperature.

Refrigerated liquid: See Cryogenic liquid.

Threshold planning quantity (TPQ): For chemicals identified as extremely hazardous substances (EHSs), the threshold quantity is 55 gallons, 500 pounds or the threshold planning quantity (TPQ).

Threshold Quantity (TQ): An inventory safety threshold quantity established in 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals.

Toxic Inhalation Hazard (TIH): Gases and volatile liquids that are toxic when inhaled (same as PIH).

UCVE: Unconfined vapor explosions.

Vapor density: Weight of a volume of pure vapor or gas (with no air present) compared to the weight of an equal volume of dry air at the same temperature and pressure. A vapor density less than 1 indicates that the vapor is lighter than air and will tend to rise. A vapor density greater than 1 indicates that the vapor is heavier than air and may travel along the ground.

Vapor pressure: Pressure at which a liquid and its vapor are in equilibrium at a given temperature. Liquids with high vapor pressures evaporate rapidly.

Viscosity: Measure of a liquid’s internal resistance to flow. This property is important because it indicates how fast a material will leak out through holes in containers or tanks.

Warm zone: Area between hot and cold zones where personnel and equipment decontamination and hot zone support take place. It includes control points for the access corridor and thus assists in reducing the spread of contamination. It can also be referred to as the contamination reduction corridor (CRC), contamination reduction zone (CRZ), yellow zone or limited access zone. (EPA Standard Operating Safety Guidelines, 29 CFR 1910.120 and NFPA® 472)

Water-sensitive: Substances which may produce flammable and/or toxic decomposition products upon contact with water.

NIMS Terms

Branch: Has functional and geographic responsibility for major segment of incident operations.

Command: Function of NIMS that dictates strategy of incident, with input from other levels of the organizational structure.

Division: Organizational level having responsibility for operations within a defined geographic area.

Group: Has responsibility for a specified functional assignment at an incident.

Incident Action Plan (IAP): Contains strategic goals, tactical objectives and support requirements.

Incident Commander (IC): Individual responsible for the management of all incident operations.

Incident Command Post (ICP): Established location from which the command function operates.

Resources: All personnel, tools and equipment, and extinguishing agents.

Supervisor: Individual responsible for commanding a division or group.

Appendix C: Acronyms and Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
AEGL	Acute Exposure Guideline Level
APIE	Analyze, Plan, Implement and Evaluate
APR	Air-purifying respirator
ARCO	Atlantic Richfield Company
ATM	Atmosphere
AZF	AZote Fertilisant
BLEVE	Large, boiling liquid expanding vapor explosion
BP	British Petroleum
BP	Boiling point
CAAA	Clean Air Act Amendments
CAMEO	Computer-Aided Management of Emergency Operations
CANUTEC	Canadian Transport Emergency Centre
CAS	Chemical Abstracts Service
CFR	Code of Federal Regulations
CHEMTREC	Chemical Transportation Emergency Center
CHRIS	Chemical Hazards Response Information System
CO	Carbon monoxide
CO_2	Carbon dioxide
CPC	Chemical protective clothing
CRC	Contamination reduction corridor
CRZ	Contamination reduction zone
CSB	United States Chemical Safety and Hazard Investigation Board
DOL	United States Department of Labor
DOT	United States Department of Transportation
EHS	Extremely Hazardous Substances
EMS	Emergency medical services
EMT	Emergency medical technician
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERG	Emergency Response Guidebook
ERP	Emergency response plan
ERPG	Emergency response planning guidelines
Fl.P	Flash point (NIOSH abbreviation)
FMC	Food Machinery Corporation
FRZ	Freezing point
HazMat	Hazardous materials (used only in IAFF department title)
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	Hydrogen chloride
HCN	Hydrogen cyanide
HHC	Highly Hazardous Chemicals

IAFF	International Association of Fire Fighters
IAP	Incident action plan
IC	Incident commander
ICP	Incident Command Post
ICS	Incident Command System
ID	Identification
IDLH	Immediately Dangerous to Life or Health
ILO	International Labor Organization
IP	Ionizaton potential
kg	Kilograms
LC50	Lethal concentration 50
LEL	Lower explosive limit
LEPC	Local Emergency Planning Committees
MIC	Methyl isocyanate
MLT	Melting point
mmHg	Millimeters of mercury
MSDS	Material safety data sheets
MW	Molecular Weight
NaTS	Sodium thiosulfate
NFPA®	National Fire Protection Association®
NIOSH	National Institute for Occupational Safety and Health
NO	Nitric oxide
NO_2	Nitrogen dioxide
OSHA	Occupational Safety and Health Administration
P	Polymerize
PEL	Permissible exposure limit
pH	A measure of the acidity or alkalinity of a solution
PIH	Poison inhalation hazard
POC	Point-of-contact
PPE	Personal protective equipment
psi	Pounds per square inch
REL	Recommended exposure limit
RgasD	Relative density of gases
RMP	Risk Management Program
SARA	Superfund Amendments and Reauthorization Act
SCBA	Self-contained breathing apparatus
SERC	State Emergency Response Commission
SFPC	Structural Fire Fighting Protective Clothing
SIC	Standard Industrial Classification
SOG	Standard operating guideline
SOL	Solubility
SOP	Standard operating procedure
Sp.Gr.	Specific gravity (NIOSH abbreviation)
TAC	Triallyl cyanurate

TIH	Toxic inhalation hazard
TLV-C	Threshold limit value/ceiling
TLV-STEL	Threshold limit value/short term exposure limit
TLV-TWA	Threshold limit value/time-weighted average
TPQ	Threshold planning quantities
TQ	Threshold quantity
UCVE	Unconfined vapor explosion
UEL	Upper explosive limit
VD	Vapor density
VP	Vapor pressure
WMD	Weapons of mass destruction

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Appendix D: Resources

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Chemical Process Industry Checklist

SECTION I – LOCATION INFORMATION

Address:

Building/Site Name:

Type of Facility:

Owner:

Owner’s Address:

Owner’s Telephone:

Emergency Telephone:

Cleanup Contractor:

SECTION II – EMERGENCY RESPONSE

Emergency Response Plan ☐ Yes ☐ No Has plan been initiated? ☐ Yes ☐ No

Obtained all MSDSs and any supporting documents ☐ Yes ☐ No

Obtained copy of Facility Incident Report ☐ Yes ☐ No

Facility Emergency Response Team: ☐ Yes ☐ No

Level of Training of Team: ____

APIE Risk-Based Response Actions

Indicate actions taken at the scene by all responding agencies and private companies.

- ☐ Analyze the problem
  - ☐ Initiate ICS
  - ☐ Survey the incident
  - ☐ Collect hazard and response information
  - ☐ Identify container type and stress
  - ☐ Predict behavior
  - ☐ Estimate outcomes

- ☐ Plan the response
  - ☐ Describe response objectives
  - ☐ Determine PPE needs
  - ☐ Describe decon issues
  - ☐ Select response options

- ☐ Implement the plan
  - ☐ Establish and enforce scene control
    - ☐ Secure area
    - ☐ Control crowd
    - ☐ Control traffic
    - ☐ Determine zones
      - ☐ Hot
      - ☐ Warm
      - ☐ Cold
  - ☐ Set up/perform decon
  - ☐ Perform protective actions
    - ☐ Rescue/recovery
    - ☐ Evacuation
    - ☐ Shelter-in-place
    - ☐ Patient transport
  - ☐ Use PPE
  - ☐ Perform control options

- ☐ Evaluate the progress
  - ☐ Evaluate response status
  - ☐ Communicate response status

Incident Command Post Location: ____

Staging Area: ____

SECTION III – ACCOUNTABILITY

Number of Employees: ________

Shifts: ____

Evacuation Plan: ☐ Yes *(If yes, obtain copy of plan)* ☐ No

Evacuation Locations:

____

____

Injuries *(Attach page with names, EMS reports and hospitals to which victims were transported)*:

Number of Employees: ________________________________

Number of Civilians: __________________________________

Number of Civilians Outside the Facility: ________________

Agencies Called to Assist: *Copy ID if possible*
(List all agencies and private companies called to assist)

Agency:

Name:

Telephone Number:

Agency:

Name:

Telephone Number:

Agency:

Name:

Telephone Number:

Agency: ____

Name: ____

Telephone Number: ____

Agency: ____

Name: ____

Telephone Number: ____

Agency: ____

Name: ____

Telephone Number: ____

SECTION IV – INCIDENT

Description:

Chemical/Trade Name(s) *(attach MSDS)*:

Level of Risk:

Amount Released:

Weather *(every hour)*

	Time	Time	Time	Time	Time	Time	Time	Time
Wind Direction								
Speed								
Temperature (Fº)								
Clear								
Cloudy								
Rain								
Fog								
Ice/hail								
Snow								

☐ **Site Plan** *(attach a copy of a detailed site plan and/or blueprints of facility and buildings)*

Facility and Building Diagram should include locations of:

- Hazardous materials
- Emergency shutoff valves of storage tanks and/or processes
- Electric control rooms
- Built-in protection systems
- Water supply
- Building access and egress
- Vulnerable areas/reactive materials and processes
- Gas shutoffs
- Fire hydrants and standpipe connections
- Fixed fire monitors
- Storage of propane or other chemical cylinders
- Fixed monitoring locations (chemical fixed monitors and/or security video)

SECTION V – BUILDING INFORMATION

Specific Property Use:

____

Number of Stories: ______

Age of Building: _________

Construction Type:

1st Type _________%
2nd Type _________%

1 = Fire Resistive
2 = Protective Non-Combustible
3 = Protected Ordinary
4 = Protected Wood Frame
5 = Heavy Timber
6 = Unprotected
7 = Unprotected Ordinary
8 = Unprotected Wood Frame

Relevant Features:

____

____

____

Type of Roof Construction: ____

Standpipes

Exterior Connections Locations: ____

Interior Connections: ____

Wet:____

Dry: ____

Sprinkler Systems

Exterior Connection Location: ____

Coverage:
Wet: _________ %
Dry: _________ %
Both: _________ %

Shut-off Location: ____

Valves:

Open (Y/N) _____ Supervised (Y/N) _____ Zoned Areas (Y/N) _____

Other Extinguishing Systems (halon, CO_2, dry powder, etc.):

____

____

Location: ____

Warning System

Detection Type (heat, smoke, both): ______________________________________

Connection to Alarm (local, central, master, auxiliary): ________________________

Alarm Company: ____

Telephone:____

SECTION VI – BUILDING HAZARDS

Common Hazards - *List any common hazards (heating system, combustibles, transformers) in the building and their locations.*

____

____

____

____

Utilities - *List type and location of utility shutoffs (natural gas, electrical).*

____

____

Special Hazards - *List any special hazards (acetylene, propane tanks, other chemicals) in the building, and their locations, including types of containers (attach MSDS for each chemical).*

____

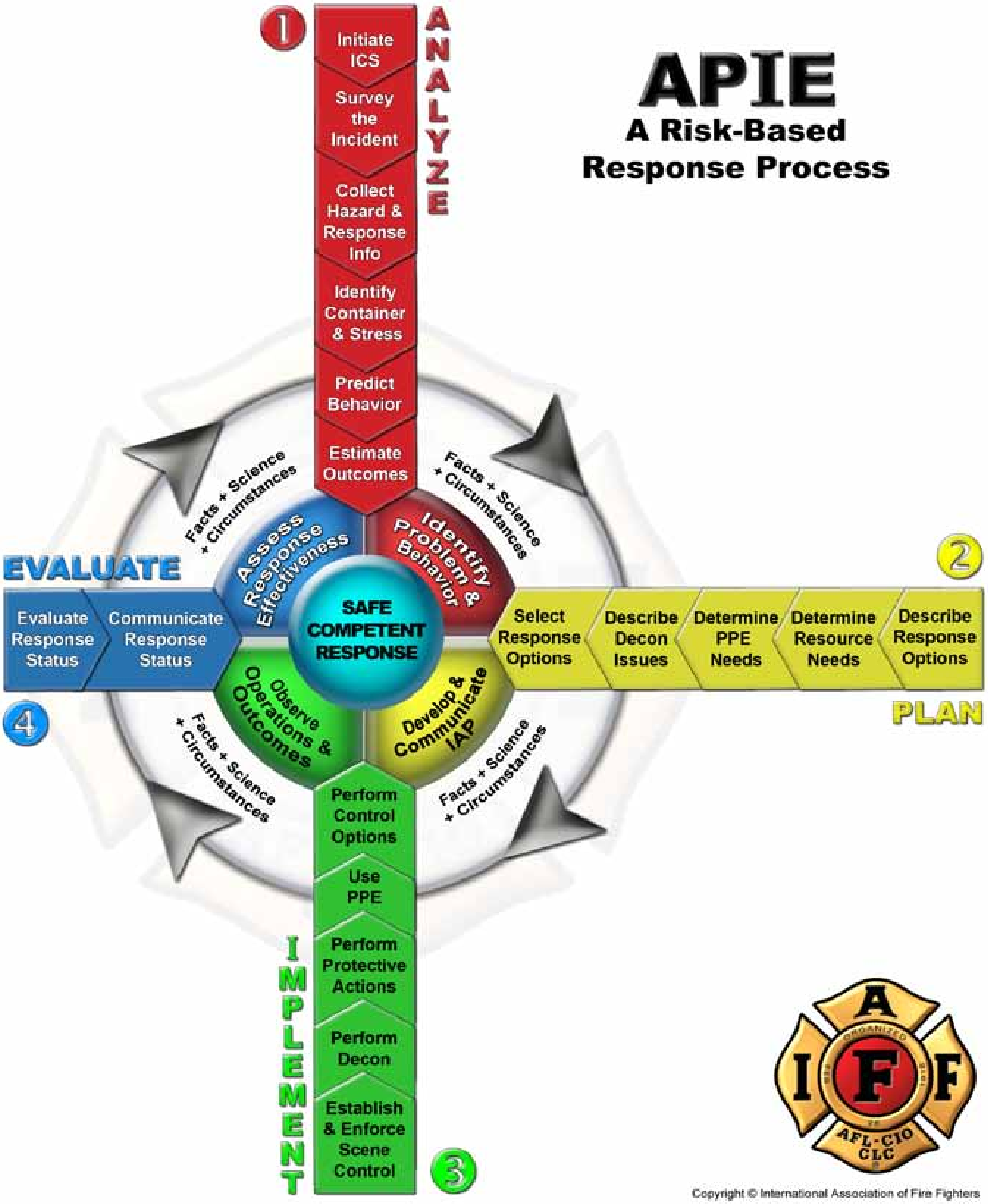
____

SECTION VII – HYDRANT LOCATIONS AND PLACEMENT OF APPARATUS

Attach a copy of the site plan with hydrants and preferred apparatus locations highlighted.

SECTION VIII – EXPOSURES TO BE PROTECTED/ EVACUATED

Attach a copy of the site plan with specific hazards/vulnerable areas identified and highlighted that are outside the property line of the facility (i.e. schools, nursing homes, other facilities).


APIE
A Risk-Based
Response Process
1
ANALYZE
Initiate ICS
Survey the Incident
Collect Hazard & Response Info
Identify Container & Stress
Predict Behavior
Estimate Outcomes
2
PLAN
Select Response Options
Describe Decon Issues
Determine PPE Needs
Determine Resource Needs
Describe Response Options
3
IMPLEMENT
Perform Control Options
Use PPE
Perform Protective Actions
Perform Decon
Establish & Enforce Scene Control
4
EVALUATE
Evaluate Response Status
Communicate Response Status
Identify Problem & Behavior
Develop & Communicate IAP
Observe Operations & Outcomes
Assess Response Effectiveness
SAFE COMPETENT RESPONSE
Facts + Science + Circumstances
Facts + Science + Circumstances
Facts + Science + Circumstances
Facts + Science + Circumstances

Risk-Based Response Actions

Analyze the Problem *GOAL = Identify the Problem and Likely Behavior*

- ☐ Initiate ICS
- ☐ Survey the incident
- ☐ Collect hazard and response information
- ☐ Identify container type and stress
- ☐ Predict behavior
- ☐ Estimate outcomes

Plan the Response *GOAL = Develop and Communicate the IAP*

- ☐ Describe response objectives
- ☐ Determine PPE needs
- ☐ Describe decon issues
- ☐ Select response options

Implement the Plan *GOAL = Observe Operations and Outcomes*

- ☐ Establish and enforce scene control
    - ☐ Secure area
    - ☐ Control crowd
    - ☐ Control traffic
    - ☐ Determine zones
        - ☐ Hot
        - ☐ Warm
        - ☐ Cold
- ☐ Set up/perform decon
- ☐ Perform protective actions
    - ☐ Rescue/recovery
    - ☐ Evacuation
    - ☐ Shelter-in-place
    - ☐ Patient transport
- ☐ Use PPE
- ☐ Perform control options

Evaluate the Progress *GOAL = Assess Response Effectiveness*

- ☐ Evaluate response status
- ☐ Communicate response status

APIE Worksheet

Analyze the Problem GOAL = Identify the Problem and Likely Behavior

Use the Chemical/Physical Properties Identification Form (next page) to help you collect the hazard information you'll need to predict behavior of hazmats and containers and estimate outcomes. Use the space below for your notes.

Type of Incident

☐ Fire/explosion ☐ Release ☐ Confined space ☐ Reactive chemicals

Initiate ICS ______________________________

____

Survey the Incident ______________________________

____

Collect Hazard and Response Information ______________________________

____

Identify Container Type(s) and Stress ______________________________

____

Predict Behavior ______________________________

____

Estimate Outcomes ______________________________

____

Chemical/Physical Properties Identification Form

Product/Chemical Names:	References Used:

Chemical and Physical Properties

Physical State:	Form:	Vapor Pressure: mmHg/ATM
Flammable: Yes/No	LEL: %	UEL: %

Flash Point (Fl.P): ºF/C	Boiling Point (BP): ºF/C
Ignition (Auto) Temperature: ºF/C	

Molecular Weight (MW):	Vapor Density (VD):
Lighter/Heavier than Air:	Volatility:
Specific Gravity (Sp.Gr.);	Solubility (SOL):
Corrosive: pH	Reactive (with):
Polymerization (potential): Yes/No	

Radioactive: Yes/No	Alpha:	Beta:	Gamma:

Health

Toxic: Yes/No	Routes of Exposure: Inhalation/Absorption/Ingestion/Injection

Exposure Limits:	TLV-TWA:	TLV-STEL:
TLV-C:	PEL	IDLH:
Comments:		

Plan the Response GOAL = Develop and Communicate the IAP

Use the space below for your notes.

Describe Response Objectives ____________________

____

____

Determine Personnel/Equipment Needs ____________________

____

____

Determine PPE Needs ____________________

____

____

Describe Decon Issues ____________________

____

____

Select Response Objectives ____________________

____

____

Implement the Plan GOAL = Observe Operations and Outcomes

Use the space below for your notes.

Establish and Enforce Scene Control ____

Perform Decon ____

Perform Protective Actions ____

Use PPE ____

Perform Control Options ____

Evaluate the Progress GOAL = Assess Response Effectiveness

Use the space below for your notes.

Evaluate Response Status

Communicate Response Status

Page left blank intentionally. Use for notes.