# RATIONALE FOR THE DEVELOPMENT OF A LIST OF REGULATED SUBSTANCES UNDER CEPA SECTION 200 AND THEIR THRESHOLD QUANTITIES

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#### **ACRONYMS**

ASTM American Society for Testing and Materials

BATF United States Bureau of Alcohol, Tobacco, and Firearms

CAS Chemical Abstracts Service

CEPA Canadian Environmental Protection Act 1999

CEPA NAC Canadian Environmental Protection Act National Advisory Committee

CFR Code of Federal Regulations

conc Concentration

CRAIM Conseil pour la réduction des accidents industriels majeurs

DOD United States Department of Defense
DOT United States Department of Transportation

DSL Domestic Substance List (Part II of the Canada Gazette, May 4, 1994)

E2 Environmental Emergency
EEC European Economic Communities

EHS Extremely Hazardous Substances (EPCRA, SARA Title III, section 302)

EPA Environmental Protection Agency (United States)

EPCRA Emergency Planning and Community Right to Know Act (enacted in 1986 by the

United States Congress)

ERPG Emergency Response Planning Guidelines (American Industrial Hygiene

Association)

IDLH Immediately Dangerous to Life and Health

IMO International Maritime Organization

LC<sub>50</sub> Lethal concentration 50% (Concentration of the chemical in air at which 50% of

the test animals died)

LC<sub>LO</sub> Lethal concentration low (Lowest concentration of the chemical in air at which

any test animals died)

 $LD_{50}$  Lethal dose 50% (Dose (ingested) of the chemical that killed 50% of the test

animals)

LD<sub>LO</sub> Lethal dose low (Lowest dose (ingested) of the chemical at which any test

animals died)

MIACC Major Industrial Accidents Council of Canada

m metre millimetre

mol wt Molecular Weight

MSHA United States Mine Safety and Health Administration

N.A. Not Available

NFPA National Fire Protection Association

NIOSH National Institute for Occupational Safety and Health

NTP National Toxicology Program

OSHA Occupational Safety and Health Administration (United States)

PIN/UN Product Identification Number (United Nations)

psi Pound per Square Inch

RMP Risk Management Program (United States Environmental Protection Agency)

RTECS Registry of Toxic Effects of Chemical Substances

SARA Superfund Amendments and Reauthorization Act (enacted in 1986 by the U.S.

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Congress)

SEVESO Directive dealing with major accident hazards by the Council of the European

Communities (Identified by the name of a city in Italy where a major accident

happened in 1976)

t Metric tonnes (1,000 kg)

TDG Transportation of Dangerous Goods regulation

TNO Netherlands Organization for Applied Scientific Research

TNT Trinitrotoluene

TPQ Threshold Planning Quantities

TQ Threshold Quantities

TSCA Toxic Substances Control Act

U.S. EPA United States Environmental Protection Agency

V Volatility

#### **PREFACE**

## Rationale for the development of a list of regulated substances under CEPA Section 200 and their threshold quantities

#### **PREFACE**

Environment Canada's mandate is to preserve and enhance the quality of the natural environment and its vision is to see a Canada where people make responsible decisions about the environment, and where the environment is thereby sustained for the benefit of present and future generations. The mission of its Environmental Emergencies program is to reduce the frequency, severity and consequences of environmental emergencies.

The events of September 11<sup>th</sup> highlighted the need for increased action to prevent and prepare for potential threats to national security. Canadians are becoming more aware of the risks and are demanding that we adopt appropriate emergency management programs that meet international standards and best practices, to address natural and human-caused incidents, including terrorist threats.

Hence, Environment Canada will be using powers under the *Canadian Environmental Protection Act 1999* (CEPA 1999) to ensure that industrial facilities using dangerous substances have emergency plans in place to prevent accidents, and respond quickly and effectively to protect the environment and the health of Canadians in the event of an accident, vandalism or terrorist attack. Part 8 of CEPA, Environmental matters related to emergencies (Sections 193 to 205) provides the Minister of the Environment with various powers to address environmental emergencies.

Two of the authorities that have been identified as being particularly relevant in taking action under Part 8 are Sections 199 and 200 respecting the prevention of, preparedness for, response to and recovery from an environmental emergency (E2).

CEPA Part 8 allows the Minister of the Environment to require E2 plans for toxic or other hazardous substances. The primary objective for requiring E2 planning under Sections 199 and 200 is to ensure that appropriate risk management measures are adopted and implemented for all potential risks associated with the manufacture, storage and use of toxic and hazardous substances in Canada.

Environment Canada has reviewed the relationship between taking action under Section 199 dealing solely with CEPA toxics and that under Section 200, which provides a much broader scope of authority. The department has concluded that the most effective and efficient means of achieving departmental objectives is to require E2 Plans for both CEPA toxics and other hazardous substances by regulation under Section 200. At the same time, the Minister still retains the authority to require E2 Plans for CEPA toxics under Section 199.

Section 200 allows the federal government to establish a list of substances that if they enter the environment as a result of environmental emergency: a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity b) constitutes or may constitute a danger to the environment on which human life depends, or c) constitutes or may constitute a danger in

Canada to human life or health. An E2 plan would be required of all facilities that store or use any of these substances at or above the specified threshold quantities.

On December 18, 2001, Environment Canada hosted a multi-stakeholder consultation on the proposed Section 200 regulations under CEPA. Approximately 40 groups or individuals were represented at the session. Stakeholders included affected industry sectors and their associations (e.g. Canadian Chemical Producer's Association, Canadian Petroleum Products Institute, Mining Association of Canada, Canadian Fertilizer Institute, Canadian Association of Agri-Retailers and Forest Products Association of Canada), various non-government organizations (e.g. Environmental organizations, Federation of Canadian Municipalities, Canadian Association of Fire Chiefs), provincial/municipal representatives and other federal departments and agencies.

The consultations confirmed that there is general support for the proposed regulation and consensus was reached to utilize the list of substances and thresholds developed by the "Conseil pour la réduction des accidents industriels majeurs" (CRAIM 2001) as the basis for the drafting of the proposed initial regulation. CRAIM is the Montréal regional chapter of the former Major Industrial Accidents Council of Canada (MIACC).

The CEPA National Advisory Committee (NAC) was also engaged through a series of regular briefings. The provinces too are generally supportive of the initiative; the only issue being the need to avoid duplication with any provincial requirements in this area. Environment Canada is cognizant of the need to avoid duplication with any other federal and/or provincial requirements. The department has initiated dialogue with federal and provincial/territorial agencies to identify and resolve any such potential duplication. It is fully committed to pursuing administrative agreements or other mechanisms to eliminate or minimize any such duplication.

The CRAIM list of hazardous substances was developed using a multi-stakeholder process that reviewed and adopted all the hazardous substances from the Risk Management Program (RMP) developed by the U.S. Environmental Protection Agency (EPA) and a selection of chemicals from the Major Industrial Accident Council of Canada (MIACC) lists.

The revised CRAIM List of 174 substances contains: 63 inflammables (RMP), 77 toxics (RMP), 10 inflammables (MIACC / Occupational Safety and Health Administration (OSHA) or National Fire Protection Association (NFPA)), 20 toxic (MIACC / OSHA or NFPA), 3 explosives and 1 miscellaneous. It was designed to take into account the List of hazardous substances from the EPA Risk Management Program (RMP) while also retaining the most hazardous substances from MIACC List 2.

Hazardous substance threshold quantities were established using the principle of "equivalence of harm".

Knowledge of where specific toxic or hazardous substances exist in Canada and their quantities, has been a critical missing element in preparing for emergencies from an environmental, health protection and national security perspective.

The proposed environmental emergency (E2) regulation under Section 200 of CEPA will initially cover some 174 substances that, if released to the environment as a result of an environmental emergency, act of terrorism or vandalism, may harm human health α environmental quality. They include 16

substances that are either on the List of Toxic Substances (Schedule 1) under CEPA 1999 or are proposed to be added to the List. Hence the regulation will address both CEPA toxics and other hazardous substances of concern.

Canadian facilities subject to the proposed regulation would be required to submit: a notice containing information on the location and quantities of listed substances; a second notice that the required E2 plan has been prepared and a third notice that the E2 plan has been implemented; within 90 days, six months and one year, respectively; of the later of, the proposed regulation coming into force or after a substance reaches or exceeds the prescribed quantity.

Regulated facilities will have the option of submitting the required information in hard copy or electronically. Once reviewed, the notices (minus any legitimate confidential business information or information deemed to be of concern from a national security perspective) will be posted on the EEB website where they will be available for public review. In concert with the Canadian Security Intelligence Service, steps will be taken to manage the sensitive information in a way that does not place Canadians at risk, and access to such information by potential criminal or terrorist elements is prevented.

Under the proposed regulations, a flexible approach to E2 planning is being pursued, thereby providing regulated facilities latitude to reflect local conditions and situations in the development and implementation of the E2 plans.

The E2 plan will have to: identify all major potential environmental emergencies, the potential impact on human health and the environment, including both on-site and off-site consequences, and the associated prevention efforts underway as well as the preparedness, response and recovery capabilities; describe the roles and responsibilities of individuals during an environmental emergency including contact numbers; identify training required for emergency response personnel; include a list of the emergency response equipment available and their location and measures to be used to notify members of the public who would be adversely affected. A copy of the E2 plan must be kept on site and be available for inspection.

In addition, there are provisions for the automatic updating of significant changes to the notices such as: any increase equal to or greater than 10% in the maximum expected quantity reported; or location of substance; or any change at any time after the filing to head office. An amended notice must be filed within 60 days after that time. If the person no longer has the substance at or above the prescribed quantities for 1 year, an amended notice must be filed within 90 days after that time.

Existing E2 plans prepared for other purposes may suffice or may have to be amended or modified only to the extent of any inconsistencies with the requirements under this regulation. Where such a plan does not meet all the requirements of the regulation, the plan shall be amended to meet the remainder of those requirements.

As part of an ongoing auditing process, Environment Canada will be requesting both on a random or targeted manner, copies of some of these environmental emergency plans to be submitted to the department for review. Such action would help Environment Canada assess whether the departmental guidance on environmental emergency planning is adequate and being properly

interpreted. Otherwise, more prescriptive measures such as those in the U.S. could be required in the future, if warranted.

Environment Canada undertook consultations with both CEPA NAC and other key stakeholders, prior to finalizing the legal text of the proposed regulations for publication in Canada Gazette Part 1.

The rationale for the CRAIM list described in this document focuses almost exclusively on human health and safety issues. It identifies the primary sources for the various substances included in the CRAIM list (namely U.S. EPA, OSHA and MIACC) and details the original evaluation criteria used by these organizations. The document also explains how, based on the level of severity within the different ranking schemes used, threshold quantities for toxic, flammable and explosive substances were derived. As one would expect, the threshold amount varies inversely with the calculated level of severity of the hazard for each substance.

Environment Canada recognizes the limitations in the scope of the issues the CRAIM list and its source lists are designed to address. Thus, the department plans to refine the environmental emergencies data gathering guidelines, the risk evaluation framework and the rationale to incorporate environmental considerations in keeping with the goals of the Canadian Environmental Protection Act, i.e. the mutual protection of both the environment and human health. The three conditions for the application of the environmental emergencies provisions under CEPA are described in Section 194 of the Act.

Environment Canada will continue to assess the remaining CEPA toxics and other substances of concern, (eg. pesticides, biologics and ammonium nitrate) for possible future inclusion on the Section 200 list. As part of this ongoing process, substances may be added or dropped from the current list and thresholds adjusted if new data show that to be warranted.

Environment Canada also intends to initiate dialogue with both the United States and Mexico on the opportunities for and potential benefits of taking a more harmonized approach to environmental emergency planning across North America.

#### 1. Scope of the Regulations

Section 200 in CEPA provides for the following authorities:

200. (1) The Governor in Council may, on the recommendation of the Minister and after the Committee is given an opportunity to provide its advice to the Minister under section 6, make regulations

- a) establishing a list of substances that, if they enter the environment as a result of an environmental emergency,
  - i) have or may have an immediate or long-term harmful effect on the environment or its biological diversity,
  - ii) constitute or may constitute a danger to the environment on which human life depends, or
  - iii) constitute or may constitute a danger in Canada to human life or health;
- b) prescribing, in respect of a substance on the list established under paragraph (a), a minimum quantity;
- c) respecting the identification of the places in Canada where a substance referred to in paragraph (a), in any quantity or in the quantity prescribed for that substance under paragraph (b), is located and requiring notification to the Minister of those places;
- d) respecting the prevention of, preparedness for, response to and recovery from an environmental emergency in respect of a substance;
- e) respecting the notification and reporting of an environmental emergency;
- *f)* respecting the notification and reporting of the measures taken:
  - i) to prevent the environmental emergency, or
  - ii) to repair, reduce or mitigate any negative effects on the environment or human life or health that result from the environmental emergency or that may reasonably be expected to result from it;
- g) respecting the implementation of international agreements entered into by Canada in relation to environmental emergencies; and
- *h)* respecting any other matter necessary for the purposes of this Part.

#### 1.1. Options for Developing Hazardous Substances List and Thresholds

Work on developing lists of substances that pose a threat to human health or environmental quality as a result of an accidental or unplanned release has been underway in many North American and European jurisdictions for some time. Of particular importance are the following lists that have been developed:

- In Canada by the now-defunct Major Industrial Accidents Council of Canada (MIACC);
- By the U.S. Environmental Protection Agency under their Risk Management Planning Rule;
- By the Council of the European Communities under their Seveso Directive dealing with major accident hazards; and
- By the "Conseil pour la réduction des accidents industriels majeurs" (CRAIM) working group in the Montréal region in their risk management guide.

Listed substances are not the only substances that can cause harm to human life or health or to the environment. Listed substances in smaller quantities than their threshold quantities can, under some circumstances, cause harm to human life or health or the environment. The responsibility to prevent the release of "extremely hazardous substances"\* is the general duty of owners and operators of facilities producing, processing, handling and storing such substances, whether or not explicit requirements have been imposed under the proposed regulation under CEPA 1999 Section 200. Therefore, there is a General Duty for owners and operators of stationary sources producing, processing handling or storing "extremely hazardous substances" ... to identify hazards which may result from releases using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases and to minimize the consequences of accidental release which do occur.

\* "Extremely Hazardous Substances" include any agent "which may or may not be listed or otherwise identified by any Government agency which may as the result of short term exposures associated with releases to the air cause death, injury or property damage due to its toxicity, reactivity, volatility or corrosivity". (US Senate Committee on Environment and Public Works, Clean Air Act Amendments of 1989, Senate Report No 228, 101st Congress, First Session 211 (1989) – Senate Report

#### 2. CRAIM List of Hazardous Substances

The CRAIM List contains: 63 flammables (RMP), 77 toxics (RMP), 10 flammables (MIACC - OSHA or NFPA 325), 20<sup>1</sup> toxic (MIACC - OSHA or NFPA 325), 3 explosives and 1 miscellaneous substance for a total of 174 substances. It was designed to take into account the list of hazardous substances from the EPA Risk Management Program (RMP) while retaining the most hazardous substances from MIACC List 2 in accordance with the following logic:

<sup>&</sup>lt;sup>1</sup> CRAIM Guide lists 21 toxic substances from MIACC Lists, however one substance is duplicated under a synonym. Therefore the list was reduced to 20 toxic substances.

- MIACC List 1, Priority Hazardous Substances.
- RMP lists of toxic and flammable substances with their threshold quantities<sup>2</sup>.
- Hazardous substances from MIACC Lists 2 and 3 when they are listed in the RMP list or in the United States Occupational Safety and Health Administration regulation on Process Safety Management (1910.119)<sup>3</sup> or in the list of substances under the National Fire Protection Association (NFPA) 325 *Fire Hazards Properties of Flammable Liquids, Gases, and Volatile Solids* when the substances are classified as '4', either for health, fire or reactivity<sup>4</sup>. See Table 1 for definition of the classification NFPA '4'. The complete definitions of health, fire and instability (reactivity) hazards are presented in Appendix A.
- The threshold quantities that were retained are, in order of preference, those regulated under RMP or if not available those of OSHA 1910.119 or MIACC List 2.

The process followed is illustrated in Figure 1, development of the CRAIM list.

Table 1 Definition of Health, Fire and Instability Hazards Under NFPA Level 4

Health Hazards	Fire Hazards	Instability Hazards
4	4	4
Materials that, under emergency	Materials that will rapidly or	Materials that in themselves are
conditions, can be lethal. The following	completely vaporize at atmospheric	readily capable of detonation or
criteria shall be considered when rating	pressure and normal ambient temperature	explosive decomposition or explosive
materials:	or that are readily dispersed in air, and	reaction at normal temperatures and
Gases whose LC <sub>50</sub> for acute	which will burn readily. This includes:	pressures. This includes materials
inhalation toxicity is less than or equal to	Flammable gases;	that are sensitive to localized thermal
1,000 parts per million (ppm);	Flammable cryogenic materials;	or mechanical shock at normal
Any liquid whose saturated vapor	Any liquid or gaseous material that is	temperatures and pressures.
concentration at 68°F (20°C) is equal to	liquid while under pressure and has a flash	Materials that have an
or greater than ten times its $LC_{50}$ for acute	point below 73°F (22.8°C) and a boiling	instantaneous power density
inhalation toxicity, if its LC <sub>50</sub> is less than	point below 100°F (37.8°C) (i.e., Class IA	(product of heat of reaction and
or equal to 1,000 parts per million (ppm);	liquids);	reaction rate) at 482°F (250°C) of
Dusts and mists whose LC <sub>50</sub> for acute	Materials that ignite spontaneously	1,000 W/mL or greater.
inhalation toxicity is less than or equal to	when exposed to air.	·
0.5 milligrams per liter (mg/L);		
Materials whose LD <sub>50</sub> for acute dermal		
toxicity is less than or equal to 40		
milligrams per kilogram (mg/kg);		
Materials whose LD <sub>50</sub> for acute oral		

<sup>&</sup>lt;sup>2</sup> List of Regulated Toxic and Flammable Substances and Thresholds for Accidental Release prevention, Environmental Protection Agency (EPA), Federal Register, vol. 59, no 20, 19 January 1993, pp. 4493-4499, Washington, DC.

<sup>&</sup>lt;sup>3</sup> List of Highly Hazardous Chemicals. Toxics and Reactives, Federal Register, vol. 57, no 36, 24 February 1992, Washington, DC.

<sup>&</sup>lt;sup>4</sup> NFPA 325, Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids, National Fire Protection Association, August 1994, Quincy, MA, U.S.A.

toxicity is less than or equal to 5	
milligrams per kilogram (mg/kg).	

#### 3. Development of RMP and MIACC Lists

#### 3.1. EPA Risk Management Program Lists

The U.S. EPA process for identifying hazardous substances for emergency measures was based primarily on concerns of air toxicity and physical damage (air blast effects). EPA did not include specific criteria for environmental impacts. However the impact on environmental receptors must be identified.

Environmental receptors are defined as natural areas such as national parks, forests, or monuments: officially designated wildlife sanctuaries; preserves, refuges, or areas; and Federal wilderness areas. Only environmental receptors that can be identified on local U.S. Geological Survey need to be considered. It is required to locate each of these specifically. It is only required to check off in the RMP which specific types of areas are in the circle of specified consequences. If any part of one of these receptors is within the circle, it must be noted on the RMP.

EPA has adopted under the RMP a list of 77 toxic substances with threshold quantities (TQ) which are function of the toxicity of the substance and its volatility (Table 2) and a list of 63 flammable substances (gases and volatile liquids) with one TQ of 4.5 metric tons (10,000 pounds) (Table 3).

The U.S. EPA proposed to include commercial explosives defined by the Department of Transportation (DOT) as Division 1.1 (explosives with mass explosion hazard) with a threshold quantity of 5,000 pounds. However, explosives were not included in the final list because they are regulated by several agencies and organizations such as the Bureau of Alcohol, Tobacco, and Firearms (BATF), the Department of Transportation (DOT), the Occupational Safety and Health Administration (OSHA), the Mine Safety and Health Administration (MSHA), the Department of Defense (DOD) and the International Maritime Organization (IMO).

Toxic substances were included on the list based on their toxicity, physical state, vapour pressure, and accident history.

The minimum vapour pressure for chemicals to be included on the EPA list is 10 millimetres of mercury (mm Hg) (with the exception of toluene diisocyanate which has a lower vapour pressure and which was listed as required by U.S. Congress).

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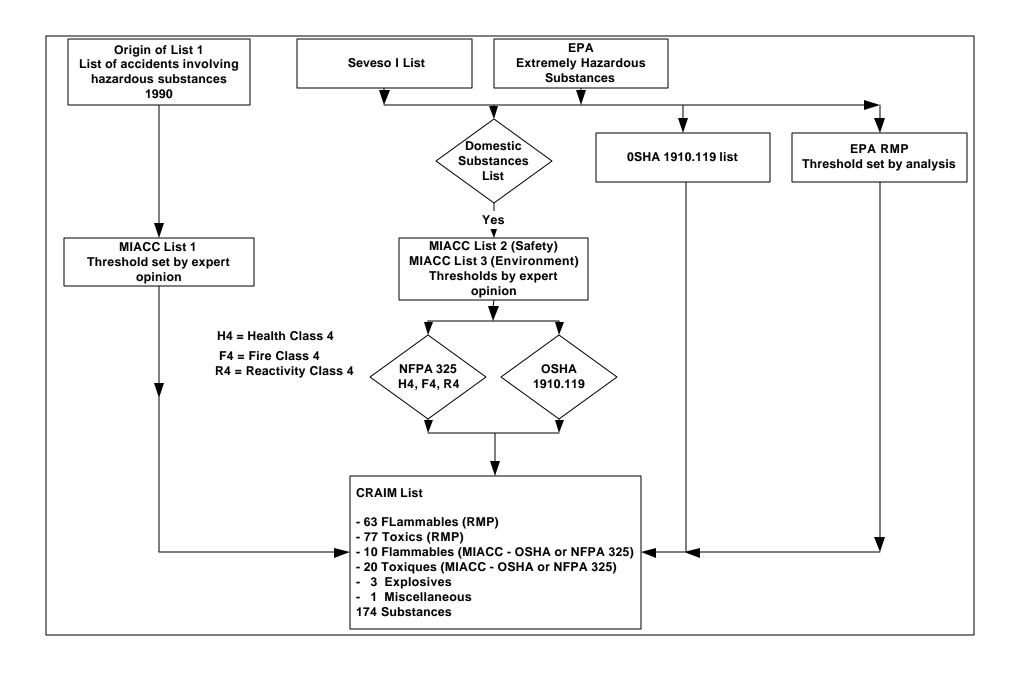


Figure 1 Development of CRAIM List

The acute toxicity criteria used are:

- (a) Inhalation LC<sub>50</sub>  $\leq$  0.5 milligrams per litre of air (for exposure time 4  $\leq$  hours), or
- (b) Dermal  $LD_{50} \le 25$  milligrams per kilogram of body weight where  $LC_{50}$  is the median concentration in air at which 50 percent of the test animals died, and  $LD_{50}$  is the median lethal dose that killed 50 percent of the test animals. In the absence of  $LC_{50}$  or  $LD_{50}$  data,  $LC_{L0}$  or  $LD_{L0}$  data were used for listing, where  $LC_{L0}$  is the lethal concentration low, or lowest concentration in air at which any of the test animals died.
- (c) A vapour pressure of 10 millimetres of mercury (mm Hg) was used as a baseline. Toxic gases and liquid with a vapour pressure of 10 mm Hg or higher under ambient conditions were considered for listing.
- (d) Only toxic chemicals in commercial production, verified through EPA's Toxic Substances Control Act (TSCA) Chemical Inventory, were included on the list.
- (e) The U.S. EPA Agency also looked at other data sources including a combination of toxicity and history of accidents involving death or injury.

U.S. EPA threshold quantities were set for toxic substances based on a ranking method that considers toxicity and volatility of the chemicals using the principle of "Equivalence of Harm". EPA assigned identical thresholds to chemicals with similar ranking scores. TQs of 0.22 metric tons (500 lbs), 0.45 metric tons (1,000 lbs), 1.13 metric ton (2,500 lbs), 2.27 metric tons (5,000 lbs), 4.50 metric tons (10,000 lbs), 6.80 metric tons (15,000 lbs) and 9.10 metric tons (20,000 lbs).

Table 2 Toxic Substances Listed In the Risk Management Program with Threshold Quantities

CAS Number	Chemical Name	EPA Threshold
		Tonnes (lbs)
107-02-8	Acrolein	2.27 (5,000)
107-13-1	Acrylonitrile	9.10 (20,000)
814-68-6	Acryloyl chloride (Acrylyl chloride)	2.27 (5,000)
107-18-6	Allyl alcohol	6.80 (15,000)
107-11-9	Allylamine	4.50 (10,000)
7664-41-7	Ammonia (anhydrous)	4.50 (10,000)
7664-41-7	Ammonia (aqueous solution, conc 20% or greater)	9.10 (20,000)
7784-34-1	Arsenous trichloride	6.80 (15,000)
7784-42-1	Arsine	0.45 (1,000)
10294-34-5	Boron trichloride	2.27 (5,000)
7637-07-2	Boron trifluoride	2.27 (5,000)
7726-95-6	Bromine	4.50 (10,000)
75-15-0	Carbon disulfide	9.10 (20,000)
7782-50-5	Chlorine	1.13 (2,500)
10049-04-4	Chlorine dioxide	0.45 (1,000)
67-66-3	Chloroform	9.10 (20,000)
542-88-1	Bis(chloromethyl ether) [Dichlorodimethyl ether]	0.45 (1,000)
107-30-2	Chloromethyl methyl ether	2.27 (5,000)
4170-30-3	Crotonaldehyde	9.10 (20,000)
123-73-9	Crotonaldehyde, (E)-	9.10 (20,000)
506-77-4	Cyanogen chloride	4.50 (10,000)

Table 2 Toxic Substances Listed In the Risk Management Program with Threshold Quantities (Continued)

CAS Number	Chemical Name	EPA Threshold
		Tonnes (lbs)
108-91-8	Cyclohexylamine	6.80 (15,000)
19287-45-7	Diborane	1.13 (2,500)
75-78-5	Dimethyldichlorosilane	2.27 (5,000)
57-14-7	Dimethylhydrazine	6.80 (15,000)
106-89-8	Epichlorohydrin	9.10 (20,000)
107-15-3	Ethylenediamine	9.10 (20,000)
151-56-4	Ethyleneimine	4. 50 (10,000)
75-21-8	Ethylene oxide	4. 50 (10,000)
7782-41-4	Fluorine	0.45 (1,000)
50-00-0	Formaldehyde solution	6. 80 (15,000)
110-00-9	Furan	2.27 (5,000)
302-01-2	Hydrazine	6.80 (15,000)
7647-01-0	Hydrochloric acid (solution, conc 37% or greater)	6.80 (15,000)
74-90-8	Hydrocyanic acid	1.13 (2,500)
7647-01-0	Hydrogen chloride (anhydrous)	2. 27 (5,000)
7664-39-3	Hydrogen fluoride/Hydrofluoric acid (conc 50% or greater)	0.45 (1,000)
7783-07-5	Hydrogen selenide	0.22 (500)
7783-06-4	Hydrogen sulphide	0.45 (1,000)
13463-40-6	Iron pentacarbonyl	1.13 (2,500)
78-82-0	Isobutyronitrile	9.10 (20,000)
108-23-6	Isopropyl chloroformate	6.80 (15,000)
126-98-7	Methacrylonitrile	4.50 (10,000)
74-87-3	Methyl chloride	4.50 (10,000)
79-22-1	Methyl chloroformate	2.27 (5,000)
60-34-4	Methyl hydrazine	6.80 (15,000)
624-83-9	Methyl isocyanate	4.50 (10,000)
74-93-1	Methyl mercaptan	4.50 (10,000)
556-64-9	Methyl thiocyanate	9.10 (20,000)
75-79-6	Methyltrichlorosilane	2.27 (5,000)
13463-39-3	Nickel carbonyl	0.45 (1,000)
7697-37-2	Nitric acid (conc 80% or greater)	6.80 (15,000)
10102-43-9	Nitric oxide	4.50 (10,000)
7664-93-9	Oleum (Fuming sulfuric acid)	4.50 (10,000)
79-21-0	Peracetic acid	4.50 (10,000)
594-42-3	Trichloromethanesulfenyl chloride (Perchloromethylmercaptan)	4.50 (10,000)
75-44-5	Phosgene	0.22 (500)
7803-51-2	Phosphine	2.27 (5,000)
10025-87-3	Phosphorus oxychloride	2.27 (5,000)
7719-12-2	Phosphorus trichloride	6.80 (15,000)
110-89-4	Piperidine	6.80 (15,000)
107-12-0	Propionitrile	4.50 (10,000)
109-61-5	Propyl chloroformate	6.80 (15,000)
75-55-8	Propyleneimine	4.50 (10,000)

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Table 2 Toxic Substances Listed In the Risk Management Program with Threshold Quantities (Continued)

CAS Number	Chemical Name	EPA Threshold Tonnes (lbs)
75-56-9	Propylene oxide	4.50 (10,000)
7446-09-5	Sulphur dioxide	2.25 (5,000)
7783-60-0	Sulphur tetrafluoride	1.13 (2,500)
7446-11-9	Sulphur trioxide	4.50 (10,000)
75-74-1	Tetramethyl lead	4.50 (10,000)
509-14-9	Tetranitromethane	4.50 (10,000)
7550-45-0	Titanium tetrachloride	1.14 (2,500)
584-84-9	Toluene-2,4-diisocyanate	4.50 (10,000)
91-08-7	Toluene-2,6-diisocyanate	4.50 (10,000)
26471-62-5	Toluene diisocyanate (Unspecified isomer)	4.50 (10,000)
75-77-4	Trichloromethylsilane	4.50 (10,000)
108-05-4	Vinyl acetate monomer	6.80 (15,000)

Flammable gases and volatile flammable liquids were included on the list based on the flash point and boiling point criteria used by the National Fire Protection Association (NFPA) for the highest hazard ranking (flash point below 73°F (22.8°C)) and boiling point below 100°F (37.8°C)<sup>5</sup>. Only flammable substances in commercial production were listed.

The threshold quantity for flammable substances was set at 4.5 metric tons (10,000 pounds) based on the potential power of a vapour cloud explosion.

Some chemicals are toxic and flammable. The ranking process took both criteria into account and TQ was set in accordance with the toxic index that was calculated. Toxic and flammable chemicals that had a toxic index that would have resulted in TQs in excess of 10,000 pounds were defaulted to 4.50 metric tons (10,000 lbs).

Explosives in Class 1.1, classified by the Department of Transportation (DOT), were proposed for listing based on their potential to detonate. The threshold quantity for explosives was set at 2.27 metric tons (5,000 pounds) because a detonation of this quantity could yield blast wave overpressure of 3.0 pounds per square inch (psi) at a distance of 100 metres from the blast site and could have potentially lethal effects in the community beyond the fence line. However, explosives were not included in the final list because several agencies and organizations regulate them. The criteria were retained by CRAIM with 3 substances that can, under some circumstances, behave as explosives: sodium chlorate, ammonium perchlorate and hydrogen peroxide. Explosives class 1.1 were removed from the list since they are governed by a specific regulation.

EPA proposed to apply the threshold quantity to the maximum potential total quantity of a substance in a process. This definition would apply to the maximum total quantity, at any one time, in a single vessel in a group of interconnected vessels or in several vessels that

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<sup>&</sup>lt;sup>5</sup> NFPA, Fire Protection Guide on Hazardous Material, 1984, 8th Edition, Quincy MA., U.S.A.

#### could potentially be involved at one time in an accidental release.

The TQs were set taking into account the potential theoretical acute impact on people for a one accidental exposure. Toxicity and explosion consequences were also considered.

 Table 3
 Flammable Substances Listed In the Risk Management Program with Threshold Quantities

CAS Number	Chemical Name	EPA Threshold
		Tonnes (lbs)
75-35-4	1,1-Dichloroethylene	4.50 (10,000)
75-37-6	1,1-Difluoroethane	4.50 (10,000)
75-38-7	1,1-Difluoroethene	4.50 (10,000)
106-99-0	1,3-Butadiene	4.50 (10,000)
504-60-9	1,3-Pentadiene	4.50 (10,000)
106-98-9	1-Butene	4.50 (10,000)
590-21-6	1-Chloro-1-propene	4.50 (10,000)
109-67-1	1-Pentene	4.50 (10,000)
74-99-7	1-Propyne	4.50 (10,000)
107-01-7	2-Butene	4.50 (10,000)
557-98-2	2-Chloro-1-propene	4.50 (10,000)
75-29-6	2-Chloropropane	4.50 (10,000)
563-46-2	2-Methyl-1-butene	4.50 (10,000)
563-45-1	3-Methyl-1-butene	4.50 (10,000)
75-07-0	Acetaldehyde	4.50 (10,000)
74-86-2	Acetylene	4.50 (10,000)
598-73-2	Bromotrifluoroethylene	4.50 (10,000)
106-97-8	Butane	4.50 (10,000)
25167-67-3	Butylene	4.50 (10,000)
79-38-9	Chlorotrifluoroethylene	4.50 (10,000)
590-18-1	Cis-2-butene	4.50 (10,000)
627-20-3	Cis-2-pentene	4.50 (10,000)
460-19-5	Cyanogen	4.50 (10,000)
75-19-4	Cyclopropane	4.50 (10,000)
7791-21-1	Dichlorine oxide	4.50 (10,000)
4109-96-0	Dichlorosilane	4.50 (10,000)
60-29-7	Diethyl ether	4.50 (10,000)
115-10-6	Dimethyl ether	4.50 (10,000)
124-40-3	Dimethylamine	4.50 (10,000)
74-84-0	Ethane	4.50 (10,000)
107-00-6	Ethyl acetylene	4.50 (10,000)
75-00-3	Ethyl chloride	4.50 (10,000)
75-08-1	Ethyl mercaptan	4.50 (10,000)
109-95-5	Ethyl nitrite	4.50 (10,000)
109-92-2	Ethyl vinyl ether	4.50 (10,000)
75-04-7	Ethylamine	4.50 (10,000)

74-85-1	Ethylene	4.50 (10,000)
1333-74-0	Hydrogen	4.50 (10,000)

Table 3 Flammable Substances Listed In the Risk Management Program with Threshold Quantities (Continued)

CAS Number	Chemical Name	EPA Threshold
		Tonnes (lbs)
75-28-5	Isobutane	4.50 (10,000)
115-11-7	Isobutylene	4.50 (10,000)
78-78-4	Isopentane	4.50 (10,000)
78-79-5	Isoprene	4.50 (10,000)
75-31-0	Isopropylamine	4.50 (10,000)
74-82-8	Methane	4.50 (10,000)
107-31-3	Methyl formate	4.50 (10,000)
75-89-5	Methylamine	4.50 (10,000)
463-82-1	Neopentane	4.50 (10,000)
109-66-0	n-Pentane	4.50 (10,000)
463-49-0	Propadiene	4.50 (10,000)
74-98-6	Propane	4.50 (10,000)
115-07-1	Propylene	4.50 (10,000)
7803-62-5	Silane	4.50 (10,000)
116-14-3	Tetrafluoroethylene	4.50 (10,000)
75-76-3	Tetramethylsilane	4.50 (10,000)
624-64-6	Trans-2-butene	4.50 (10,000)
646-04-8	Trans-2-pentene	4.50 (10,000)
10025-78-2	Trichlorosilane	4.50 (10,000)
75-50-3	Trimethylamine	4.50 (10,000)
689-97-4	Vinyl acetylene	4.50 (10,000)
75-02-5	Vinyl fluoride	4.50 (10,000)
107-25-5	Vinyl methyl ether	4.50 (10,000)

#### 3.2. MIACC Lists

The development of lists of hazardous substances initiated in 1991 by the Working Group 1 of the Major Industrial Council of Canada (MIACC), was a multistakeholder process. Three lists were developed:

- MIACC List 1 Priority Hazardous Substances
- MIACC List 2 Hazardous Substances
- MIACC List 3 Environmentally Hazardous Substances.

List 1 is a short list of "top priority" substances commonly found in Canada both in fixed facilities and transport situations. An accidental release involving a List 1 substance, at or above the specified threshold, could potentially result in a number of both on- and off-site fatalities.

List 2 is a longer list of potentially hazardous substances which are commonly found in Canada, both at facilities and in transportation situations. Any release of a List 2 substance, at or above the specified threshold, could result in on-site fatalities and off-site injuries. This includes the substances of List 1, in amounts smaller than the large quantities that merit the top priority of List 1.

List 3 comprises other hazardous substances which are frequently encountered in Canada but present smaller acute risks than those in Lists 1 and 2, and are less likely to cause or be involved in a major accident. They may present environmental or long-term risks.

The Lists give the name of the substance, the usual physical state, Chemical Abstracts Service (CAS) numbers, product identification number / United Nations number (PIN/UN), transport of dangerous goods (TDG) class and division numbers, and a threshold quantity.

# The threshold quantities were based on the $\underline{\text{expert opinion}}$ of members of MIACC Working Group 1.

Key factors considered in the compilation of MIACC Lists 1 and 2 were:

- the physical and chemical properties of the substance;
- the physical and chemical properties of the decomposition or combustion products; and,
- the historical involvement of the substance in industrial accidents (primarily its inclusion on the Environment Canada *Spills List*).

The MIACC Lists of Hazardous Substances were developed by members of MIACC who had expertise in the areas of toxicology, health and safety, emergency response, and enforcement, as the basis for identifying and ranking sites at which handling of hazardous substances takes place from the perspective of public safety risk.

The process involved review of existing lists of hazardous substances. These included the following Canadian Lists: *Transportation of Dangerous Goods Regulations, Schedule XII,* Environment Canada's Lists of Spilled Chemicals, the Montréal Urban Community's List of Dangerous Substances, the substances listed in the regulation promulgated under the *Pest Control Products Act,* and the Workplace Hazardous Materials Information System Lists. Other lists reviewed included the U.S. Environmental Protection Agency *Superfund Amendments and Re-Authorization Act, Extremely Hazardous Substance List* and the *Toxic Substances Control Act (TSCA) Inventory,* the U.S. Occupational Safety and Health (OSHA 1910.119) List, the International Labour Office *Lists of Recommendations for Process Hazards Management of Substances with Catastrophic Potential,* the *List of Substances* from the Netherlands Organization of Applied Scientific Research (TNO) *Guide to Hazardous Industrial Activities,* and the *Seveso I Directive Annex III.* Criteria for inclusion in the *MIACC Lists* were developed considering those used in the creation of the above lists along with other Canadian experience. Hazardous substances not produced or allowed to be imported into Canada at the time were eliminated from the *MIACC Lists*.

#### 3.2.1. MIACC List 1

MIACC List 1 contains 3 hazardous substances. These substances represented at the time, the substances that were involved in the highest number of accidents in Canada. An accident involving a List 1 substance and quantity could potentially result in a number of on- and off-site fatalities.

#### 3.2.2. MIACC List 2

MIACC List 2 contains 212 hazardous substances. These substances are a combination of MIACC List 1 (at lower thresholds), Extremely Hazardous Substances listed under Section 302 of the EPCRA (SARA Title III) and hazardous substances listed under SEVESO I Directive. Hazardous substances from SARA Title III and SEVESO I were retained if they were listed on the Domestic Substances List (DSL)<sup>6</sup>.

The threshold quantities in List 2 were based on the quantities set in SARA Title III, SEVESO I and the expert opinion of members of MIACC Working Group 1. The release of these substances at the quantities specified could result in on-site fatalities and off-site injuries.

#### 3.2.3. MIACC List 3

MIACC List 3 contains 68 hazardous substances. These substances were identified as environmentally hazardous substances.

#### 3.3. List of Hazardous Substances From CRAIM

Table 4 presents the List of Toxic Substances identified in the CRAIM List (CRAIM Class D).

Table 5 presents the List of Flammable Substances identified in the CRAIM List (CRAIM Class C).8

Table 6 presents the List of Explosive Substances identified in the CRAIM List (CRAIM Class E).9

Table 7 presents the List of Miscellaneous Substances identified in the CRAIM List (CRAIM Class F).<sup>9</sup>

<sup>&</sup>lt;sup>6</sup> Part II of the Canada Gazette, May 4, 1994.

<sup>&</sup>lt;sup>7</sup> CRAIM 2001, Guide de gestion des risques d'accidents industriels majeurs à l'intention des municipalités et de l'industrie, p. 118, Conseil régional pour la réduction des accidents industriels majeurs, Montréal, 2001.

<sup>&</sup>lt;sup>8</sup> CRAIM 2001, Guide de gestion des risques d'accidents industriels majeurs à l'intention des municipalités et de l'industrie, p. 119 - 120, Conseil régional pour la réduction des accidents industriels majeurs, Montréal, 2001.

<sup>&</sup>lt;sup>9</sup> CRAIM 2001, Guide de gestion des risques d'accidents industriels majeurs à l'intention des municipalités et de l'industrie, p. 120, Conseil régional pour la réduction des accidents industriels majeurs, Montréal, 2001.

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Table 4 Toxic Substances identified in the CRAIM List

CAS Number	Chemical Name	Threshold Set by Expert Opinion Tonnes
107-07-3	2-chloroethanol	1.00
107-05-1	Allyl chloride	0.45
630-08-0	Carbon monoxide	10.00
76-06-2	Chloropicrin [trichloronitromethane]	0.22
7790-94-5	Chlorosulfonic acid [chlorosulphonic acid]	1.00
506-68-3	Cyanogen bromide	1.00
10035-10-6	Hydrobromic acid [hydrogen bromide]	2.25

Table 4 Toxic Substances identified in the CRAIM List (Continued)

CAS Number	Chemical Name	Threshold Set by Expert Opinion Tonnes
463-51-4	Ketene	0.05
7439-97-6	Mercury	1.00
78-85-3	Methacrolein [methacrylaldehyde]	0.45
30674-80-7	Methacryloyloxyethyl isocyanate	0.05
74-83-9	Methyl bromide	1.15
74-88-4	Methyl iodide	3.40
78-94-4	Methyl vinyl ketone	0.05
10102-44-0	Nitrogen dioxide	0.11
20816-12-0	Osmium tetroxide	0.05
108-95-2	Phenol	10.00
7803-52-3	Stibine	0.22
78-00-2	Tetraethyl lead	1.00
7719-09-7	Thionyl chloride	0.11
7616-94-6	Perchloryl fluoride [Trioxychlorofluoride]	2.25

Table 5 Flammable Substances Identified in the CRAIM List

CAS Number	Chemical Name	Threshold Set by Expert Opinion Tonnes
107-06-2	1,2-Dichloroethane [ethylene dichloride]	50.00
75-64-9	2-methyl-2-propanamine [tert-butylamine]	10.00
71-43-2	Benzene	10.00
110-82-7	Cyclohexane	50.00
75-18-3	Dimethyl sulphide	10.00
100-41-4	Ethylbenzene	50.00
86290-81-5	Gasoline (motor fuel)	50.00
8006-14-2	Natural gas	4.50
8030-30-6	Naphtha	50.00
108-88-3	Toluene	50.00
1330-20-7	Xylenes	50.00

Table 6 Explosive Substances Identified in the CRAIM List

CAS Number 7775-09-9	Chemical Name  Sodium chlorate	Threshold Set by Expert Opinion Tonnes 10.00
	Explosives (Class 1.1)*	
7790-98-9	Ammonium perchlorate	3.40
7722-84-1	Hydrogen peroxide (conc 52% or greater)	3.40

<sup>\*</sup> Removed from the list

Table 7 Miscellaneous Substances Identified in the CRAIM List

CAS Number	Chemical Name	Threshold Set by Expert	
		Opinion	
		Tonnes	
7723-14-0	Phosphorus, white	1.00	

#### 4. Threshold Methodologies

It is important to have a sound and transparent methodology for assignment of threshold quantities for hazardous substances. The methodology should include an explanation of the basis for establishing the list and account for specific factors in setting the threshold quantities. Moreover, a sound methodology is essential for making changes to the list of substances and their threshold quantities to keep the regulation current.

The methodology should follow the principle of "Equivalence of Harm" i.e. the threshold quantities of hazardous substance in each category (toxic, flammable, etc) should be such to cause the same degree of harm.

The proposed methodology is the one that EPA used for setting up the RMP lists.

Suggestions were made that site-specific factors should be considered in setting or modifying thresholds, such as population density, ecosystems sensitivity, safety devices, experience, uses of the substance, and handling conditions. EPA recognized that these and many other site-specific factors could affect the likelihood of occurrence or the effects of a release. Accounting for these factors has the advantage of more specifically tailoring threshold quantities based on common use patterns of the substances and of the particular site in which they would be used. One serious disadvantage of applying site-specific factors to setting thresholds would be that such an approach would be inappropriate for ubiquitous chemicals, such as chlorine and ammonia, because of the innumerable applications that would have to be considered. A greater disadvantage to this approach is that the intrinsic hazard of a chemical will still be present even when it is used outside of a "typical" scenario. It is therefore not feasible to develop a methodology for establishing threshold quantities based on site-specific factors that would be applicable nationwide. However, for the threshold determination at a specific site, substance-specific factors and use scenarios can be considered in determining whether there is a threshold quantity on-site.

The RMP Methodology for choosing threshold quantities follows.

#### 4.1. Threshold Methodology for Toxic Substances

For the setting of threshold quantities for Toxic Substances under the RMP, EPA used the methodology for the development of threshold planning quantities (TPQs) developed for extremely hazardous substances (EHSs) listed under EPCRA (SARA Title III) section 302. This methodology takes into account the potential of toxic substances to become airborne, their dispersion potential, and toxicological properties, with adjustment based on chemical reactivity and other factors.

The Immediately Dangerous to Life and Health (IDLH) level developed by the National Institute of Occupational Safety and Health (NIOSH), or an approximation of the IDLH based on animal toxicity data, was used as an index of toxicity. The IDLH is defined as the maximum airborne concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects. IDLHs presented in the 1990 edition of the NIOSH *Pocket Guide to Chemical Hazards* were used where available.

Physical state and volatility were used to derive an index of the chemical's potential to become airborne and disperse. The two indices were combined to produce an overall risk "ranking factor" defined as IDLH/V, where V is the index of potential to become airborne and disperse. Threshold quantities were assigned to groups of substances according to their relative importance. See Exhibit 1 and Appendix B for Ranking of chemicals.

For substances without a published IDLH, mammalian toxicity data were used to derive a value equivalent to the IDLH as follows:, in order of preferred toxicity data:

- Estimated IDLH =  $LC_{50} \times 0.1$
- Estimated IDLH = LC<sub>LO</sub>
- Estimated IDLH =  $LD_{50} \times 0.01$
- Estimated IDLH =  $LD_{LO} \times 0.1$

Where: LC<sub>50</sub> is the median lethal concentration, the concentration of the chemical in air at which 50 percent of the test animals died;

LC<sub>LO</sub> is the lowest concentration in air at which any test animals died;

LD<sub>50</sub> is the median lethal dose, the dose that killed 50 percent of the test animals; and

LD<sub>LO</sub> is the lowest dose at which any test animals died.

Revised or updated toxicology data were used, based on the December 1990, *Registry of Toxic Effects of Chemical Substances* (RTECS).

EPA chose to use IDLH or its equivalent rather than the Emergency Response Planning Guideline level 3 (ERPG-3) or the Emergency Response Planning Guideline level 2 (ERPG-2) from the American Industrial Hygiene Association (AIHA) or some other measure of toxic concentrations because there are many more published IDLH values available than ERPG values; in addition a method is available for deriving an IDLH equivalent from toxicity data.

The Emergency Response Planning Guideline (ERPG) values are intended to provide estimates of concentration ranges above which one could reasonably anticipate observing some adverse effects as described in the definition of ERPG-3, ERPG2 and ERPG-1 as a consequence of exposure to a specific substance<sup>10</sup>:

- The ERPG-3 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
- The ERPG-2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- The ERPG-1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odour.

For the following chemicals, the following "Toxicity" criteria were used because of lack of IDLH 1990 or reliable toxicity data:

ERPG-2 (1991) Chlorosulfonic acid
ERPG-2 (2002) 1,2-Dichloroethane

• IDLH (1994) Hydrobromic acid

• IDLH (1994) Ketene

IDLH (1997) Trioxychlorofluoride
 LC<sub>50</sub> Thionyl chloride
 LC<sub>LO</sub> Cyanogen bromide

The index of potential to become airborne and disperse (V) was derived based on physical state and volatility. For substances that are gases under ambient conditions, V was assumed to have a value of 1, indicating that in an accidental release, the total quantity of chemical involved in the release could become airborne. For liquids, V was calculated by estimating the rate of volatilization from a pool (assumed to be one centimetre in depth) on a flat non-absorbing surface using equations presented in Appendix B. Liquids were assumed to be at their boiling point, and all liquids were assumed to have the same density as water. A transfer coefficient was estimated by reference to water. Because of these assumptions, the only variables used in the calculation of V were the molecular weight and boiling point of the liquid. Taking into account these assumptions, the equation used to derive V is as follows (see Appendix B for additional details):

$$V = 1.6 \times MW^{0.67}$$
$$T + 273$$

Where: MW is the molecular weight, and

T is the boiling temperature in degrees Celsius.

The toxic substances were ranked according to the ranking factor IDLH/V and assigned threshold quantities of 0.22 t (500 lbs), 0.45 t (1,000 lbs), 1.13 t (2,500 lbs), 2.27 t (5,000 lbs), 6.80 t (15,000 lbs) or 9.10 t (20,000 lbs) based on order of magnitude ranges in the ranking factors. The threshold

<sup>&</sup>lt;sup>10</sup> Emergency Response Planning Guidelines, American Industrial Hygiene Association, Fairfax, VA, 1992.

quantities selected are, at the minimum level of 0.22 t (500 lbs), representative of drum-size containers, and, at the maximum of 9.10 t (20,000 lbs). The range of threshold quantities reflect the relative hazards among the listed toxics; the upper limit of 9.10 t (20,000 lbs) represents typical handling quantities, and would still be protective of the public for those substances which would have the higher thresholds.

Several toxic substances also meet the flammability criteria, and thus could be assigned two thresholds. Toxic substances that also meet the criteria for listing as flammable substances are assigned the lower of the thresholds. For example methyl chloride which meets the criteria for listing of flammability and, therefore, is assigned the threshold quantity of 10,000 pounds rather than the 20,000 pounds that would apply under the methodology for toxics. The threshold quantities assigned based on the ranking factors were reviewed, and changes were made based on other toxicity data, rapid absorption, chemical reactivity, and consideration of specific handling, formulation, and use information.

Table 8	Threshold	Values	Index

Index	Threshold Quantities
	Tonnes (lbs)
<0.01	0.22* (500)
0.01 to <0.05	0.45* (1,000)
0.05 to <0.1	1.13* (2,500)
0.1 to <0.3	2.27* (5,000)
0.3 to <1	4.50* (10,000)
1 to <10	6.80* (15,000)
<sup>3</sup> 10	9.10* (20,000)

Note: \* Numbers rounded to the second digit.

#### 4.2. Threshold Quantities for Flammable Substances

EPA's analysis of the hazards of flammable chemicals indicates that the greatest hazard to the public from these substances is from vapour cloud explosions. Heat radiation from pool fires, vapour cloud fires, or fireball resulting from boiling liquid expanding vapour cloud explosions (BLEVEs) can also be a threat to the public. However, EPA's analysis indicates that for a given quantity of a flammable chemical, vapour cloud explosions pose the greatest threat over the greatest distance. Historical data indicate that vapour cloud explosions are unlikely for vapour cloud containing quantities less than 4 545 kg (10,000 lbs). The quantity in a vapour cloud resulting from an accidental release of a flammable gas or volatile flammable liquid could vary greatly depending on site-specific and accident-specific conditions, as well as properties of the chemical released.

EPA has a list of 62 flammable gases and volatile flammable liquids under the RMP. Because it would be difficult to set chemical-specific thresholds based on all the factors that might affect a release, EPA has chosen to set the threshold for all the listed flammable substances at 4,545 kg, based on the potential for vapour cloud explosions. EPA's analysis indicates that the detonation of 4,545 kg of a flammable vapour (e.g., ethylene, propane, propylene, etc.) could have a potentially lethal effect on people at a distance of 100 metres from the site of the detonation.

EPA believes that this threshold is conservative and protective because the vapour cloud resulting from a release of 4,545 kg would probably contain a quantity less than 4,545 kg, even though all the listed flammable substances are gases or volatile liquids. Establishing one threshold for all the flammable substances on the list also simplifies the regulatory process. The 4,545 kg is consistent with the OSHA's threshold for flammable substances in its Process Safety Management Standard. See Exhibit 2.

Substances that are listed under RMP for toxicity may also meet the criteria for listing for flammability. For these substances, the thresholds have been set based on toxicity, as described above. The substances are included on the list of toxic substances only. Toxic substances proposed for listing that meet the criteria for flammability are listed in Exhibit 3. For 11 of these substances, the TQ assigned on the basis of toxicity is lower than the 4,545 kg threshold that would be assigned on the basis of flammability. For the remaining four, the threshold would be 4,545 kg for either toxicity or flammability.

#### 4.3. Threshold Methodology for Explosives

The detonation of high explosives produces violent shock waves. EPA's analysis of explosives indicates that blast wave overpressure of 3.0 psi could have potentially lethal effects on people from the indirect effects of an explosion. This overpressure level could cause serious structural damages to buildings (which could lead to serious or fatal injuries to people), lead to serious wounds from flying glass, and potentially cause eardrum rupture. In addition, an overpressure of this level could hurl a person to the ground or against other objects, potentially causing injury. The indirect effects of a blast overpressure of 3.0 psi would probably not be lethal. Lower overpressure levels also could potentially lead to serious or fatal injuries from indirect effects such as injury from flying glass or other debris in some cases. However, for lower pressures, the likelihood of a fatality is lower because there would be less damage to buildings and flying objects would have less force. EPA decided that for the purposes of the RMP, 3.0 psi was a reasonable overpressure level to consider.

To determine a threshold for explosives, EPA used the scaling law of distances, which relates quantity of explosive material and distance for a given overpressure, to estimate the quantity of high explosives that would produce an overpressure of 3.0 psi at a distance of 100 metres in the event of a detonation. The scaling law is represented by the following equation:

$$D = K \times W^{1/3}$$

Where: D = Required, or potentially affected distance, feet.

K = Protection factor depending upon the degree of risk assumed or permitted, empirically derived based on effects of overpressure.

W = TNT equivalent weight, pounds; i.e., the weight of trinitrotoluene (TNT) that would yield the same peak overpressure or impulse at a given distance as the total weight of explosive material under consideration.

Exhibit 4 shows the distances to various overpressure levels from explosion of several quantities of high explosives, based on the scaling law, assuming the high explosive is equivalent to TNT in explosive power.

Based on calculations using the scaling law, EPA decided to set the threshold for high explosives at 2.27 t (5,000 lbs), the quantity that would lead to an overpressure of about 3 psi at a distance of 100 metres in the event of an explosion. Individual explosives may vary in their explosive capacity.

It should be noted that, for the purposes of the Section 200 regulation, explosives have been specifically excluded from consideration. This is due to the fact that they are regulated by Natural Resources Canada under the Explosives Act where the environmental emergency planning aspects are adequately addressed.

#### 4.4. Limitations of threshold quantities

Methods for setting threshold quantities for substances in each category were taken from the U.S. Environmental Protection Agency (EPA).

EPA does not consider these threshold quantities to be a precise measure of a "safe" level; no such level can be determined. The risk posed by any chemical release depends on the particular circumstances at the time of the release.

For example, releases of the same quantity of the chemical may pose very different threats depending on the location of a facility, weather at the time of the release, the elevation of the source of the release (e.g., a release from a smokestack versus a ground level release), and the pressure and temperature at the time of the substance, among other factors.

#### 4.5. Other threshold quantity options considered

In addition to the proposed methodology for setting thresholds for toxic substances, three alternative options were considered.

#### 4.5.1. Dispersion modeling

One option uses the vapour quantity method, based on air dispersion modeling, to determine the quantity in air needed to equal the "Immediately Dangerous to Life and Health (IDLH), (published by the National Institute for Occupational Safety and Health) concentration level at 100 metres from the point of release. To derive threshold quantities, a concentration level equal to the IDLH or its equivalent was assumed to be reached at a distance of 100 metres from the source of the release. The U.S. EPA calculated a release rate that would produce that concentration level at 100 m, by using air dispersion modelling techniques. The dispersion modeling used was based on equations presented in *Technical Guidance for Hazards Analysis* (EPA, Federal Emergency Management Agency (FEMA), and Department of Transport (DOT), 1987). For the calculations, moderate conditions of a wind speed of 4.3 metres per second (10 miles per hour), atmospheric stability D, and urban conditions were assumed. The duration of the release was assumed to be 30 minutes (because the IDLH is based on a 30-minute exposure), and a quantity was calculated by multiplying the release rate by the duration. For comparison, the same calculations were carried out assuming extreme conditions of wind speed 1.5 metres per second stability F, and open, rural conditions.

The assumptions made for modeling had a great effect on the results obtained. The quantity calculated assuming moderate conditions is approximately 100 times less than that calculated assuming extreme conditions. Varying the assumptions could lead to many different calculated quantities. The quantity calculated is directly proportional to the wind speed, the dispersion coefficients, the toxic concentration, and the duration of the release.

It was felt that such an approach would be difficult to implement on a national basis. The conditions at the time of an actual release could vary greatly; therefore, the results of chemical-specific calculations such as those carried out using this methodology may have little relation to what might happen during an actual release.

#### 4.5.2. Seveso II Directive

Here are extracts of the Seveso Directive (Seveso) for some specific obligations for operators and the lists of dangerous substances and their threshold quantities.<sup>11</sup>

#### Article 6

#### **Notification**

- 1. Member States shall require the operator to send the competent authority a notification within the following time-limits:
- for new establishments, a reasonable period of time prior to the start of construction or operation,
- for existing establishments, one year from the date laid down in Article 24 (1).
- 2. The notification required by paragraph 1 shall contain the following details:
- a) the name or trade name of the operator and the full address of the establishment concerned;
- b) the registered place of business of the operator, with the full address;
- c) the name or position of the person in charge of the establishment, if different from (a);
- d) information sufficient to identify the dangerous substances or category of substances involved;
- e) the quantity and physical form of the dangerous substances or substances involved;
- f) the activity or proposed activity of the installation or storage facility;
- g) the immediate environment of the establishment (elements liable to cause a major accident or to aggravate the consequences thereof).
- 3. In the case of existing establishments for which the operator has already provided all the information under paragraph 2 to the competent authority under the requirements of national law at the date of entry into force of the Directive, notification under paragraph 1 is not required.
- 4. In the event of:

<sup>&</sup>lt;sup>11</sup> Official Journal of the European Communities, 14 January 1997.

- any significant increase in the quantity or significant change in the nature or physical form of the dangerous substance present, as indicated in the notification provided by the operator pursuant to paragraph 2, or any change in the processes employing it, or
- permanent closure of the installation.

#### Article 7

#### **Major-accident prevention policy**

- 1. Member States shall require the operator to draw up a document setting out his major-accident prevention policy and to ensure that it is properly implemented. The major-accident prevention policy established by the operator shall be designed to guarantee a high level of protection for men and the environment by appropriate means, structures and management systems.
- 2. The document must take account of the principle's contained in Annex III (Of the Seveso directive) and be made available to the competent authorities for the purposes of, amongst other things, implementation of Articles 5 (2) and 18.
- 3. This article shall not apply to the establishments referred to in article 9.

#### Article 9

#### Safety report

- 1. Member States shall require the operator to produce a safety report for the purposes of:
- a) demonstrating that a major-accident prevention policy and a safety management system for implementing it have been put into effect in accordance with the information set out in Annex III (of the Seveso Directive);
- b) demonstrating that major-accident hazards have been identified and that the necessary measures have been taken to prevent such accidents and to limit their consequences for man and the environment;
- c) demonstrating that adequate safety and reliability have been incorporated into the design, construction, operation and maintenance of any installation, storage facility, equipment infrastructure connected with its operation which are linked to major-accident hazards inside the establishment;
- d) demonstrating that internal emergency plans have been drawn up and supplying information to enable the external plan to be drawn up in order to take the necessary measures in the event of a major accident;
- e) providing sufficient information to the competent authorities to enable decisions to be made in terms of the siting of new activities or developments around existing establishments.
- 2. The safety report shall contain at least the data and information listed in Annex II (of the Seveso Directive). It shall also contain an updated inventory of the dangerous substances present in the establishment.

Safety reports, or parts of reports, or any other equivalent reports produced in response to other legislation, may be combined to form a single safety report for the purposes of this Article, where such a format obviates the unnecessary duplication of information and the repetition of work by the operator or competent authority, on condition that all the requirements of this Article are complied with.

- 3. The safety report provided for in paragraph 1 shall be sent to the competent authority within the following time limits:
- for new establishments, a reasonable period of time prior to the start of construction or of operation,
- for existing establishments not previously covered by Directive 82/501/EEC, three years from the date laid down in Article 24 (1)
- for other establishments, two years from the date laid down in Article 24 (1),
- in the case of the periodic reviews provided for in paragraph 5, without delay.
- 4. Before the operator commences construction or operation, or in the case referred to in the second, third and fourth indents of paragraph 3, the competent authority shall within a reasonable period of receipt of the report:
- communicate the conclusions of its examination of the safety report to the operator, if necessary after requesting further information, or
- prohibit the bringing into use, or the continued use, of the establishment concerned, in accordance with the powers and procedures laid down in Article 17.
- 5. The safety report shall be periodically reviewed and when necessary updated:
- At least every five years,
- At any other time at the initiative of the operator or the request of the competent authority, where justified by new facts or to take account of new technical knowledge about safety matters, for example arising from analysis of accidents or, as far as possible "near misses", and of developments in knowledge concerning the assessment of hazards.

6.

- a) Where it is demonstrated to the satisfaction of the competent authority that particular substances present at the establishment, or any part thereof, are in a state incapable of creating a major-accident hazard, then the Member State may, in accordance with the criteria referred to in subparagraph (b), limit the information required in safety reports to those matters which are relevant to the prevention of residual major-accident hazards and the limitation of their consequences for man and the environment.
- b) Before this directive is brought into application, the Commission, acting in accordance with the procedure laid down in Article 16 of Directive 82/501/EEC, shall establish harmonized criteria for the decision by the competent authority that an establishment is in a state incapable of creating a major accident hazard within the meaning of subparagraph (a). Subparagraph (a) shall not be applicable until those criteria have been established.

c) Member States shall ensure that the competent authority communicates a list of the establishments concerned to the Commission, giving reasons. The Commission shall forward the list annually to the Committee referred to in Article 22.

It should be noted that for Part II of the Directive, the European Union used categories of substances and preparations instead of naming specifically the substances.

The choice of threshold quantities was the result of negotiations between Competent Authorities.

- 1. Mixtures and preparations are treated in the same way as pure substances provided they remain within concentration limits set according to their properties under the relevant Directives given in Part 2, Note 1, or their latest adaptation to technical progress, unless a percentage composition or other description is specifically given.
- 3. The qualifying quantities set out below relate to each establishment.
- 4. The quantities to be considered for the application of the relevant Articles are the maximum quantities that are present or are likely to be present at any one time. If dangerous substances present within an establishment are found in quantities equal to or less than 2 % of the relevant qualifying quantity, and if their location is such that it cannot act as an initiator of a major accident elsewhere on the site, they shall be ignored when calculating total quantity present on site.
- 5. The rules given in Part 2, Note 4 governing the addition of dangerous substances, or categories of dangerous substances, apply where appropriate.

### PART 1 Named substances

Where a substance or group of substances listed in Part 1 also falls within a category of Part 2, the qualifying quantities set out in Part 1 must be used.

Column1	Column 2	Column 3
Dangerous substances	Qualifying quantity (tonnes) for	
	the application of	
	Articles 6 and 7	Article 9
Ammonium nitrate <sup>1</sup>	350	2500
Ammonium nitrate <sup>2</sup>	1250	5000
Arsenic pentoxide, arsenic (V) acid and/or salts	1	2
Arsenic trioxide, arsenious (III) acid and/or salts	-	0.1
Bromine	20	100
Chlorine	10	25
Nickel compounds in inhalable powder form (nickel monoxide, nickel dioxide, nickel	-	1
sulphide, trinickel disulphide, dinickel trioxide		
Ethyleneimine	10	20
Fluorine	10	20
Formaldehyde (concentration ( 90 %)	5	50
Hydrogen	5	50
Hydrogen chloride (liquefied gas)	25	250

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Lead alkyls	5	50
Liquefied extremely flammable gases (including LPG) and natural gas	50	200
Acetylene	5	50
Ethylene oxide	5	50
Propylene oxide	5	50
Methanol	500	5000
4,4-Methylenebis(2-chloraniline) and/or salts, in powder form	1	0.01
Methyl isocyanate	1	0.15
Oxygen	200	2000
Toluene diisocyanate	10	100
Carbonyl dichloride (phosgene)	0.3	0.75
Arsenic trihydride (arsine)	0.2	1
Phosphorus trihydride (phosphine)	0.2	1
Sulphur dichloride	1	1
Sulphur trioxide	15	75
Polychlorodibenzofurans and polychlorodibenzodioxins (including TCDD), calculated in TCDD equivalent	-	0.001
The following CARCINOGENS:	0.001	0.001
4-Aminobiphenyl and/or its salts, Benzidine and/or salts, Bis(chloromethyl) ether,		
Chloromethyl methyl ether, Dimethylcarbamoyl chloride, Dimethylnitrosamine,		
Hexamethylphosphoric triamide, 2-Naphtylamine and/or salts, and 1,3-Propanesultone		
4-nitrodiphenyl		
Automotive petrol and other petroleum spirits	5000	50000

- 1. Ammonium nitrate (350 / 2500) This applies to ammonium nitrate and ammonium nitrate compounds in which the nitrogen content as a result of the ammonium nitrate is more than 28 % by weight (compounds other than those referred to in Note 2) and to aqueous ammonium nitrate solutions in which the concentration of ammonium nitrate is more than 90 % by weight.
- 2. Ammonium nitrate (1250/5000) This applies to simple ammonium-nitrate based fertilizers which comply with Directive 80/876/EEC and to composite fertilizers in which the nitrogen content as a result of the ammonium nitrate is more than 28 % in weight (a composite fertilizer contains ammonium nitrate with phosphate and/or potash).

PART 2

Categories of substances and preparations not specifically named in Part 1

Column 1	Column 2	Column 3
	Qualifying quantity (tonnes) of dangerous substances	
	as delivered in Article 3 (4), for the application of	
	Articles 6 and 7 Article 9	
1. VERY TOXIC	5	20
2. TOXIC	50	200
3. OXIDIZING	50	200
4. EXPLOSIVE (where the substance or preparation falls within	50	200
the definition given in Note 2 (a))		
5. EXPLOSIVE (where the substance or preparation falls within	10	50
the definition given in Note 2 (b))		
6. FLAMMABLE (where the substance or preparation falls	5000	50000
within the definition given in Note 3 (a))		
7 a. HIGHLY FLAMMABLE (where the substance or	50	200
preparation falls within the definition given in Note 3 (b) (1))		
7 b. HIGHLY FLAMMABLE liquids (where the substance or	5000	50000

preparation falls within the definition given in Note 3 (b) (2))		
8. EXTREMELY FLAMMABLE (where the substance or	10	50
preparation falls within the definition given in Note 3 (c))		
9. DANGEROUS FOR THE ENVIRONMENT in combination		•
with risk phrases:		
(i) R50: 'Very toxic to aquatic organisms'	200	500
(ii) R51: 'Toxic to aquatic organisms'; and R53: 'May cause long	500	2000
term adverse effects in the aquatic environment'		
10. ANY CLASSIFICATION not covered by those given above in		•
combination with risk phrases:		
(i) R14: 'Reacts violently with water' (including R14/15)	100	500
(ii) R29: 'in contact with water, liberates toxic gas'	50	200

#### NOTES

- 1. Substances and preparations are classified according to the following Directives (as amended) and their current adaptation to technical progress.
  - Council Directive 67/548/EEC of 27 June 1967 on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances <sup>12</sup>.
  - Council Directive 88/379/EEC of 7 June 1988 on the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations<sup>13</sup>,
  - Council Directive 78/631/EEC of 26 June 1978 on the approximation of the laws of the Member States relating to the classification, packaging and labelling of dangerous preparations (pesticides)<sup>14</sup>

In the case of substances and preparations which are not classified as dangerous according to any of the above Directives but which nevertheless are present, or are likely to be present, in an establishment and which possess or are likely to possess, under the conditions found at the establishment, equivalent properties in terms of major-accident potential, the procedures for provisional classification shall be followed according to the relevant Article of the appropriate Directive.

In the case of substances and preparations with properties giving rise to more than one classification, for the purposes of this Directive the lowest thresholds shall apply.

For the purposes of this Directive, a list providing information on substances and preparations shall be established, kept up to date and approved by the procedure set up under Article 22.

#### 2. An 'explosive' means:

a) a substance or preparation which creates the risk of an explosion by shock, friction, fire or other sources of ignition (risk phrase R 2),

<sup>&</sup>lt;sup>12</sup> Official Journal of the European Communities No 196, 16.8.1967, p.1. Directive as fast amended by Directive 93/105/EC (OJ No L 294, 30.11.1993, p.21).

<sup>&</sup>lt;sup>13</sup> Official Journal of the European Communities No L 187, 16.7.1988, p.14.

<sup>&</sup>lt;sup>14</sup> Official Journal of the European Communities No L 206, 29.7.1978, p.13. Directive as fast amended by Directive 92/32/EEC (OJ No L 154, 5.6.1992, p.1).

- a pyrotechnic substance is a substance (or mixture of substances) designated to produce heat, light, sound, gas or smoke or a combination of such effects through nondetonating self-sustained exothermic chemical reactions, or
- c) an explosive or pyrotechnic substance or preparation contained in objects;
- d) a substance or preparation which creates extreme risks of explosion by shock, friction,
   fire or other sources of ignition (risk phrase R 3).
- 3. 'Flammable', 'highly flammable', and 'extremely flammable' in categories 6, 7 and 8 mean:
  - a) flammable liquids:

substances and preparations having a flash point equal to or greater than 21°C and less than or equal to 55°C (risk phrase R 10), supporting combustion;

- b) highly flammable liquids:
  - substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any input of energy (risk phrase R 17),
    - substances which have a flash point lower than 55°C and which remain liquid under pressure, where particular processing conditions, such as high pressure or high temperature, may create major-accident hazards;
  - o substances and preparations having a flash point lower than 21°C and which are not extremely flammable (risk phrase R 11, second indent);
- c) extremely flammable gases and liquids:
  - o liquid substances and preparations which have a flash point lower than 0°C and the boiling point (or, in the case of a boiling range, the initial boiling point) of which at normal pressure is less than or equal to 35°C (risk phrase R 12, first indent), and
  - o gaseous substances and preparations which are flammable in contact with air at ambient temperature and pressure (risk phrase R 12, second indent), whether or not kept in the gaseous or liquid state under pressure, excluding liquefied extremely flammable gases including liquefied petroleum gases (LPG) and natural gas referred to in Part 1, and
  - liquid substances and preparations maintained at a temperature above their boiling point.
  - The addition of dangerous substances to determine the quantity present at an establishment shall be carried out according to the following rule:

if the sum

where

qx = the quantity of dangerous substances x (or category of dangerous substances) falling within Parts 1 or 2 of this Annex,

Q = the relevant threshold quantity from Parts 1 or 2,

then the establishment is covered by the relevant requirements of this Directive.

This rule will apply for the following circumstances:

- for substances and preparations appearing in Part 1 at quantities less than their individual qualifying quantity present with substances having the same classification from Part 2, and the addition of substances and preparations with the same classification from Part 2;
- for the addition of categories 1, 2 and 9 present at an establishment together;
- for the addition of categories 3, 4, 5, 6, 7a, 7b and 8, present at an establishment together.

### 4.5.3. United States Occupational Safety and Health Administration

The United States Occupational Safety and Health Administration (OSHA) thresholds quantities for toxic substances listed in the Process Safety Management Standard (57 FR 6356, February 24, 1992) are based on dispersion modeling. OSHA did not specify the concentrations that were used in deriving the thresholds. Specific conditions are as follows:

- Meteorological conditions are assumed to be the average conditions (4.3 m/s wind speed, D stability).
- Continuous, steady-state release over one hour.
- All vapour release (no-liquid pool).
- No momentum effects (no initial velocity for release).
- Ground level release and receptors.
- No deposition or reaction of cloud.
- Neutrally buoyant cloud.
- Urban dispersion coefficients.
- No mitigating design or operating features to limit the rate or duration of the release or minimize its transport beyond the facility boundary.

OSHA regulates flammable liquids and gases under certain conditions, with a threshold of 4,545 kg (10,000 lbs).

# 5. Threshold calculation for Substances in CRAIM List Originating from MIACC Lists

The list of substances and the threshold quantities for toxic substances originating from the MIACC Lits were based on expert opinion.

These threshold quantities were recalculated using the methodology that the U.S. Environmental Protection Agency used for the RMP. The principle of "Equivalent Harm" was followed. The IDLH published in 1990 were used for assessing toxicity. The 1990 IDLH values were chosen to be consistent with the RMP numbers. Future updates of the threshold quantities could be formulated using appropriate toxicity levels. The detailed calculations are presented in Exhibit 5. A summary is presented in Table 9 for toxics and Table 10 for flammables. It is recommended that the MIACC threshold quantities that are currently based on expert opinion which are difficult to trace and reproduce, be replaced by the calculated thresholds using RMP methodology.

Table 9 Recalculated Threshold for Toxic Substances in CRAIM List Originating From MIACC Lists

Chemical	CRAIM Threshold Quantity	Recalculated Thresholds Quantities Using RMP Methodology with IDLH 1990 Criteria
	Tonnes (lbs)	Tonnes (lbs)
1,2-Dichloroethane <sup>1</sup>	50.00 (110,000)	6.80 (15,000)
2-Chloroethanol	1.00 (2,200)	4.50 (10,000)
Allyl Chloride	0.45 (1,000)	9.10 (20,000)
Carbon monoxide	10.00 (22,000)	6.80 (15,000)
Chloropicrin	0.22 (500)	2.27 (5,000)
Chlorosulphonic acid	1.00 (2,200)	2.27 (5,000)
Cyanogen bromide	1.00 (2,200)	4.50 (10,000)
Hydrobromic acid	2.25 (5,000)	1.13 (2,500)
Ketene	0.05 (110)	0.22 (500)
Mercury <sup>2</sup>	1.00 (2,200)	1.00 (2,200)

Table 9 Recalculated Threshold for Toxic Substances in CRAIM List Originating From MIACC Lists (Continued)

Chemical	CRAIM Threshold Quantity Tonnes (lbs)	Recalculated Thresholds Quantities Using RMP Methodology with IDLH 1990 Criteria Tonnes (lbs)
Methacryloyloxyethyl isocyanate	0.05 (1,000)	Essentially not in Canadian commerce
Methacrolein (Methacrylaldehyde)	0.45 (110)	Essentially not in Canadian commerce
Methyl bromide	1.15 (2,500)	6.80 (15,000)
Methyl iodide	3.40 (7,500)	4.50 (10,000)
Methyl vinyl ketone	0.05 (1,000)	Essentially not in Canadian commerce
Nitrogen dioxide	0.11 (220)	1.13 (2,500)
Osmium tetroxide	0.05 (110)	0.22 (500)
Phenol	10.00 (22,000)	9.10 (20,000)
Stibine	0.22 (500)	2.27 (5,000)
Tetraethyl lead	1.00 (2,200)	2.27 (5,000)
Thionyl Chloride	0.11 (220)	6.80 (15,000)
Trioxychlorofluoride	2.25 (5,000)	6.80 (15,000)

Notes: 1. 1,2-Dichloroethane reclassified as toxic using ERPG-2 (2002)

2. No change

Table 10 Recalculated Threshold for Flammables Substances in CRAIM List Originating From MIACC Lists

Chemical	CRAIM Threshold Quantity Tonnes (lbs)	Recalculated Thresholds Quantities Using RMP Methodology Tonnes (lbs)
1,2-Dichloroethane <sup>1</sup>	50 (110,000)	
Benzene	10 (22,000)	10 (22,000) <sup>2</sup>
Gasoline	50 (110,000)	150 (330,000) <sup>3</sup>
Cyclohexane	50 (110,000)	550 (1,210,000)
Ethylbenzene	50 (110,000)	7 000 (15,400,000)
Ethylbenzene	50 (110,000)	7 000 (15,400,000)
Natural gas	4.5 (10,000)	4.5 (10,000) <sup>4</sup>
Petroleum ether	50 (110,000)	50 (110,000) <sup>4</sup>
Dimethyl sulphide	10 (22,000)	150 (330,000)
t-Butylamine	10 (22,000)	150 (330,000)
Toluene	50 (110,000)	2 500 (5,500,000)
Xylene	50 (110,000)	8 000 (17,600,000)

#### Notes:

- 1. 1,2-Dichloroethane was reclassified as toxic
- 2. Threshold reflects potential carcinogenic properties.
- 3. Based on winter gasoline properties
- 4. No changes

#### 6. Hydrochloric Acid

Hydrochloric acid was improperly classified at a minimum concentration of 37%. Hydrochloric acid at 37% at 25°C has a vapour pressure of 105 mm Hg well in excess of the 10 mm criteria. It is recommended to use Hydrochloric acid at 30 % (vapour pressure 15.1 mm Hg at 25°C)

### 7. Hydrogen fluoride

It is recommended that an entry be added in the toxic substances list for hydrogen fluoride (CAS 7664-39-3) to distinguish this substance from hydrofluoric acid.

## 8. Explosive and Miscellaneous Substances Identified in the CRAIM List

Hydrogen peroxide at concentration of 52% or greater, sodium chlorate, ammonium perchlorate and explosive class 1.1 are listed as explosives in the CRAIM List and white phosphorus is listed as a substance that can cause a significant impact (in case of fire). With the exception of explosives class 1.1 governed by specific regulations, the remainder of the substances in this group were retained.

#### 9. Conclusion

The CRAIM List of Hazardous Substances represents a reasonable basis for the development of a list of substances under Section 200 of the Canadian Environmental Protection Act. This list contains all the hazardous substances of the U.S. EPA Risk Management Program (RMP) representing a good base to initiate dialogue with both the United States and Mexico on the opportunities for, and potential benefits of, taking a more harmonized approach to environmental emergency planning across North America. Hazardous substances originating from the Major Industrial Accidents Council of Canada (MIACC) were added to the RMP list. The MIACC substances and threshold quantities were identified through a group of experts' consensus while the substances from the RMP lists went through a more traceable approach. A system for recalculation is proposed to bring the toxic substances from MIACC list to the same basis as the RMP substances.

#### 10. References

CEPA 1999, Canadian Environmental Protection Act, 1999

CRAIM 2001 Guide de gestion des risques d'accidents industriels majeurs à l'intention des municipalities et de l'industrie, Conseil pour la reduction des accidents industriels majeurs, Montréal 2001

(RMP Lists) *List of Regulated Toxic and Flammable Substances and Thresholds for Accidental Release prevention, Environmental Protection Agency (EPA)*, Federal Register, vol. 59, no 20, 19 January 1993, pp. 4493-4499, Washington, DC.

(Seveso) Official Journal of the European Communities, 14 January 1997.

Exhibit 1 Toxic Substances Listed In the Risk Management Program with Threshold Quantities

CAS Number	Chemical Name	EPA Threshold Tonnes (lbs)
7783-07-5	Hydrogen selenide	0.22 (500)
75-44-5	Phosgene	0.22 (500)
7784-42-1	Arsine	0.45 (1,000)
10049-04-4	Chlorine dioxide	0.45 (1,000)
542-88-1	Bis(chloromethyl ether) [dichlorodimethyl ether]	0.45 (1,000)
7782-41-4	Fluorine	0.45 (1,000)
7664-39-3	Hydrogen fluoride/Hydrofluoric acid (conc 50% or greater)	0.45 (1,000)
7783-06-4	Hydrogen sulphide	0.45 (1,000)
13463-39-3	Nickel carbonyl	0.45 (1,000)
7782-50-5	Chlorine	1.13 (2,500)
19287-45-7	Diborane	1.13 (2,500)
74-90-8	Hydrocyanic acid (hydrogen cyanide)	1.13 (2,500)
13463-40-6	Iron pentacarbonyl	1.13 (2,500)
7783-60-0	Sulphur tetrafluoride	1.13 (2,500)
7550-45-0	Titanium tetrachloride	1.14 (2,500)
7647-01-0	Hydrogen chloride	2. 27 (5,000)
7446-09-5	Sulphur dioxide	2.25 (5,000)
107-02-8	Acrolein	2.27 (5,000)
814-68-6	Acryloyl chloride [Acrylyl chloride]	2.27 (5,000)
10294-34-5	Boron trichloride	2.27 (5,000)
7637-07-2	Boron trifluoride	2.27 (5,000)
107-30-2	Chloromethyl methyl ether (methyl chloromethyl ether)	2.27 (5,000)
75-78-5	Dimethyldichlorosilane (dichlorodimethylsilane)	2.27 (5,000)
110-00-9	Furan	2.27 (5,000)
79-22-1	Methyl chloroformate	2.27 (5,000)
75-79-6	Methyltrichlorosilane	2.27 (5,000)
7803-51-2	Phosphine	2.27 (5,000)
10025-87-3	Phosphorus oxychloride	2.27 (5,000)
7726-95-6	Bromine	4.50 (10,000)
151-56-4	Ethyleneimine	4.50 (10,000)
75-21-8	Ethylene oxide	4.50 (10,000)
624-83-9	Methyl isocyanate	4.50 (10,000)
74-93-1	Methyl mercaptan	4.50 (10,000)
584-84-9	Toluene-2,4-diisocyanate	4.50 (10,000)
107-11-9	Allylamine	4.50 (10,000)
7664-41-7	Ammonia	4.50 (10,000)
506-77-4	Cyanogen chloride	4.50 (10,000)
126-98-7	Methylacrylonitrile	4.50 (10,000)
74-87-3	Methyl chloride	4.50 (10,000)
10102-43-9	Nitric oxide	4.50 (10,000)
8014-95-7	Oleum (Fuming sulfuric acid)	4.50 (10,000)
79-21-0	Peroxyacetic acid (Peracetic acid)	4.50 (10,000)
594-42-3	Perchloromethyl mercaptan	4.50 (10,000)
107-12-0	Propionitrile	4.50 (10,000)
75-55-8	Propyleneimine	4.50 (10,000)
75-56-9	Propylene oxide	4.50 (10,000)

Exhibit 1 Toxic Substances Listed In the Risk Management Program with Threshold Quantities (continued)

		EPA Threshold
<b>CAS Number</b>	Chemical Name	Tonnes (lbs)
7446-11-9	Sulphur trioxide	4.50 (10,000)
75-74-1	Tetramethyl lead	4.50 (10,000)
509-14-9	Tetranitromethane	4.50 (10,000)
91-08-7	Toluene-2,6-diisocyanate	4.50 (10,000)
26471-62-5	Toluene diisocyanate (Unspecified isomer)	4.50 (10,000)
75-77-4	Trimethylchlorosilane (chlorotrimethylsilane)	4.50 (10,000)
50-00-0	Formaldehyde, solution	6.80 (15,000)
60-34-4	Methyl hydrazine (monomethyl hydrazine)	6.80 (15,000)
57-14-7	1,1-Dimethylhydrazine	6.80 (15,000
107-18-6	Allyl alcohol	6.80 (15,000)
7784-34-1	Arsenic trichloride (Arsenous trichloride)	6.80 (15,000)
108-91-8	Cyclohexylamine	6.80 (15,000)
302-01-2	Hydrazine	6.80 (15,000)
7647-01-0	Hydrochloric acid (conc 37% or greater)	6.80 (15,000)
108-23-6	Isopropyl chloroformate	6.80 (15,000)
7697-37-2	Nitric acid (conc 80% or greater)	6.80 (15,000)
7719-12-2	Phosphorus trichloride	6.80 (15,000)
110-89-4	Piperidine	6.80 (15,000)
109-61-5	n-Propyl chloroformate (propyl chloroformate)	6.80 (15,000)
108-05-4	Vinyl acetate	6.80 (15,000)
107-13-1	Acrylonitrile	9.10 (20,000)
7664-41-7	Ammonia solution (conc 20% or greater)	9.10 (20,000)
75-15-0	Carbon disulfide	9.10 (20,000)
67-66-3	Chloroform (trichloromethane)	9.10 (20,000)
4170-30-3	Crotonaldehyde	9.10 (20,000)
123-73-9	Crotonaldehyde, (E)-	9.10 (20,000)
106-89-8	Epichlorohydrin	9.10 (20,000)
107-15-3	Ethylenediamine	9.10 (20,000)
78-82-0	Isobutyronitrile	9.10 (20,000)
556-64-9	Methyl thiocyanate	9.10 (20,000)

Exhibit 2 Flammable Substances Listed In the Risk Management Program with Threshold Quantities

CAS Number	Chemical Name	EPA Threshold
		Tonnes (lbs)
75-35-4	1,1-Dichloroethylene (vinylidene chloride)	4.50 (10,000)
75-37-6	1,1-Difluoroethane (difluoroethane)	4.50 (10,000)
75-38-7	1,1-difluoroethylene (vinylidene fluoride)	4.50 (10,000)
106-99-0	1,3-Butadiene	4.50 (10,000)
504-60-9	1,3-Pentadiene	4.50 (10,000)
106-98-9	1-Butene	4.50 (10,000)
590-21-6	1-Chloro-1-propene (1-chloropropylene)	4.50 (10,000)
109-67-1	1-Pentene	4.50 (10,000)
74-99-7	methylacetylene (propyne)	4.50 (10,000)
107-01-7	2-Butene	4.50 (10,000)
557-98-2	2-chloro-1-propene (2-chloropropylene)	4.50 (10,000)
75-29-6	2-Chloropropane (isopropyl chloride)	4.50 (10,000)
563-46-2	2-Methyl-1-butene	4.50 (10,000)
563-45-1	3-Methyl-1-butene	4.50 (10,000)
75-07-0	Acetaldehyde	4.50 (10,000)
74-86-2	Acetylene	4.50 (10,000)
598-73-2	Bromotrifluoroethylene	4.50 (10,000)
106-97-8	Butane	4.50 (10,000)
25167-67-3	Butylene (butene)	4.50 (10,000)
79-38-9	trifluorochloroethylene (Chlorotrifluoroethylene)	4.50 (10,000)
590-18-1	Cis-2-butene (2-butene-cis)	4.50 (10,000)
627-20-3	Cis-2-pentene (beta-cis-amylene)	4.50 (10,000)
460-19-5	Cyanogen	4.50 (10,000)
75-19-4	Cyclopropane	4.50 (10,000)
7791-21-1	Chlorine monoxide (Dichlorine oxide)	4.50 (10,000)
4109-96-0	Dichlorosilane	4.50 (10,000)
60-29-7	Ethyl ether (Diethyl ether)	4.50 (10,000)
115-10-6	Dimethyl ether (methyl ether)	4.50 (10,000)
124-40-3	Dimethylamine	4.50 (10,000)
74-84-0	Ethane	4.50 (10,000)
107-00-6	Ethylacetylene	4.50 (10,000)
75-00-3	Ethyl chloride	4.50 (10,000)
75-08-1	Ethyl mercaptan	4.50 (10,000)
109-95-5	Ethyl nitrite	4.50 (10,000)
109-92-2	Vinyl ethyl ether (Ethyl vinyl ether)	4.50 (10,000)
75-04-7	Ethylamine	4.50 (10,000)
74-85-1	Ethylene	4.50 (10,000)
1333-74-0	Hydrogen	4.50 (10,000)
75-28-5	Isobutane	4.50 (10,000)
115-11-7	Isobutylene (2-methylpropene)	4.50 (10,000)

Exhibit 2 Flammable Substances Listed In the Risk Management Program with Threshold Quantities (continued)

CAS Number	Chemical Name	EPA Threshold
		Tonnes (lbs)
78-78-4	Isopentane (2-methylbutane)	4.50 (10,000)
78-79-5	Isoprene	4.50 (10,000)
75-31-0	Isopropylamine	4.50 (10,000)
74-82-8	Methane	4.50 (10,000)
107-31-3	Methyl formate	4.50 (10,000)
74-89-5	Methylamine	4.50 (10,000)
463-82-1	Neopentane	4.50 (10,000)
109-66-0	n-Pentane (pentane)	4.50 (10,000)
463-49-0	Propadiene	4.50 (10,000)
74-98-6	Propane	4.50 (10,000)
115-07-1	Propylene	4.50 (10,000)
7803-62-5	Silane	4.50 (10,000)
116-14-3	Tetrafluoroethylene	4.50 (10,000)
75-76-3	Tetramethylsilane	4.50 (10,000)
624-64-6	Trans-2-butene (2-butene-trans)	4.50 (10,000)
646-04-8	Trans-2-pentene (trans-beta-amylene)	4.50 (10,000)
10025-78-2	Trichlorosilane	4.50 (10,000)
75-50-3	Trimethylamine	4.50 (10,000)
689-97-4	1-buten-3-yne (Vinyl acetylene)	4.50 (10,000)
75-02-5	Vinyl fluoride	4.50 (10,000)
107-25-5	Vinyl methyl ether	4.50 (10,000)

Exhibit 3 Substances Listed In RMP That Match Criteria for Flammability and Toxicity

CAS Number	Chemical Name	EPA Threshold Tonnes (lbs)
7784-42-1	Arsine Chemical Name	0.45 (1,000)
506-77-4	Cyanogen chloride	4.50 (10,000)
	, ,	` ' '
19287-45-7	Diborane	1.13 (2,500)
75-21-8	Ethylene oxide	4.50 (10,000)
50-00-0	Formaldehyde, solution	6.8 (15,000)
110-00-9	Furan	2.27 (5,000)
74-90-8	Hydrocyanic acid (hydrogen cyanide)	1.13 (2,500)
7783-07-5	Hydrogen selenide	0.22 (500)
7783-06-4	Hydrogen sulphide	0.45 (1,000)
74-87-3	Methyl chloride	4.50 (10,000)
74-93-1	Methyl Mercaptan	4.50 (10,000)
7803-51-2	Phosphine	2.27 (5,000)
75-55-8	Propyleneimine	4.50 (10,000)
75-56-9	Propylene oxide	4.50 (10,000)

Exhibit 4 Affected Distances for Commercial High Explosives Based on the Scaling Law, Assuming TNT Equivalency of One (Peak Overpressure = 0.4 - 3.0 psi)

Af	Affected Distances for Various Overpressures (metres)												
Quantity	2.72 kPa	3.40 kPa	6.80 kPa	13.61	20.41								
kg (lbs)	(0.4 psi)	(0.5 psi)	(1.0 psi)	(2.0 psi)	(3.0 psi)								
23 (50)	97	79	48	29	22								
45 (100)	119	99	61	37	28								
114 (250)	160	134	83	50	38								
450 (1,000)	251	213	131	79	61								
900 (2,000)	326	269	165	100	77								
2 270 (5,000)	431	365	224	136	104								

Exhibit 5 Threshold Calculation for Toxic Substances in CRAIM List Originating from MIACC Lists

Chemical	Physical state		Basis for CRAIM Threshold		ı	LEVEL OF	CONCERN	- TOXICITY	ſ		Mol wt	Boiling T (deg C)	V	IDLH Index	CRAIM TQ, Tonnes (lbs)	NEW TQ Tonnes (lbs)	Comment
			IDLH 1990 (gm/m <sup>3</sup> )	IDLH 1994 (gm/m <sup>3</sup> )	IDLH 1997 (gm/m³)	ERPG-2 1991 (gm/m³)	ERPG-2 2002 (gm/m <sup>3</sup> )	LC <sub>50</sub> / 10 (gm/m <sup>3</sup> )	LC <sub>LO</sub> / 10 (gm/m <sup>3</sup> )								
1,2-Dichloroethane	L	Expert judgement					0.810			99.0	83	0.098	8.294	50 (110,000)	6.8 (15,000)	Decrease TQ to 6,8 t (15,000 lbs) based on ERPG-2 (2002)	
2-Chloroethanol	L	Expert judgement	0.033							80.5	128.7	0.076	0.436	1.0 (2,200)	4.5 (10,000)	Raise TQ to 4.5 t (10,000 lbs) based on IDLH (1990)	
Allyl chloride	L	Expert judgement	0.939							76.5	45	0.092	10.208	1.0 (2,200)	9.10 (20,000)	Raise TQ to 9.1 t (20,000 lbs) based on IDLH (1990)	
Carbon monoxide	G	Expert judgement	1.725							28.0	-191.7	1.000	1.725	4.5 (10,000)	6.8 (15,000)	Raise TQ to 6.8 t (15,000 lbs) based on IDLH (1990)	
Chloropicrin	L	Expert judgement	0.027							164.4	112	0.125	0.240	0.7 (1,540)	2.27 (5,000)	Raise TQ to 2.27 t (5,000 lbs) based on IDLH (1990)	
Chlorosulfonic acid	L	Expert judgement				0.011 <sup>1</sup>				116.5	152	0.091	0.121	1.0 (2,200)	2.27 (5,000)	Raise TQ to 2.27 t (5,000 lbs) based on ERPG-2 (1991)	
Cyanogen bromide	L	Expert judgement							0.0398 <sup>2</sup>	105.9	62	0.109	0.366	1.0 (2,200)	4.5 (10,000)	Raise TQ to 4.5 t (10,000 lbs) based on chemical repository 13 LC <sub>LO</sub> (92 ppm) divided by 10	
Hydrobromic acid	G	Expert judgement		0.099 <sup>3</sup>						80.9	-66.7	1.000	0.099	2.27 (5,000)	1.13 (2,500)	Decrease TQ to 1.13 t (2,500 lbs) based on IDLH (1994)	
Ketene	G	Expert judgement		0.0094						42	-56.1	1.000	0.009	0.05 (110)	0.22 (500)	Raise TQ to 0.22 t (500 lbs) based on IDLH (1994)	
Mercury	L	Expert judgement	0.028							200.6	356.7	0.089	0.316	1.0 (2,200)	4.5 (10,000)	Raise TQ to 4.5 t (10,000 lbs) based on IDLH (1990)	
Methacrolein (Methacrylaldehyde)	L	Expert judgement	N.A							70.1	68	0.081	N.A.	N.A.	N.A.	Removed based on CRAIM Board decision Essentially not in Canadian Commerce	
Methacryloyloxyeth yl isocyanate	L	Expert judgement	N.A.							155.2	211	0.095	N.A.	N.A.	N.A.	Removed based on CRAIM Board decision Essentially not in Canadian Commerce	
Methyl bromide	G	Expert judgement	7.780							95.0	3.33	1.000	7.780	1.14 (2,500)	6.8 (15,000)	Raise TQ to 6.8 t (15,000 lbs) based on IDLH90	
Methyl iodide	L	Expert judgement	4.640							141.9	42.8	0.140	33.112	3.4 (7,500)	9.10 (20,000)	Raise TQ to 4.5 t (10,000 lbs) based on IDLH90	
Methyl vinyl ketone	L	Expert. Judgement	N.A.							70.1	80	0.077	N.A.	N.A.	N.A.	Removed based on CRAIM Board decision Essentially not in Canadian Commerce	
Nitrogen dioxide	G	Expert judgement	0.094							46	21.1	1.000	0.094	0.1 (220)	1.13 (2,500)	Raise TQ to 1.13 t (2,500 lbs) based on IDLH (1990)	
Osmium tetroxides	S	Expert judgement	0.001							254.2	130	1.000	0.001	0.05 (110)	0.22 (500)	Raise TQ to 0.22 t (500 lbs) based on IDLH (1990)	

Exhibit 5 Threshold Calculation for Toxic Substances in CRAIM List Originating from MIACC Lists (Continued)

Chemical	Physical state	Basis for CRAIM Threshold	LEVEL OF CONCERN - TOXICITY								Boiling T (deg C)	V	IDLH Index	CRAIM TQ, Tonnes (lbs)	NEW TQ Tonnes (lbs)	Comment
			IDLH90 (gm/m³)	IDLH 1994 (gm/m <sup>3</sup> )	1DLH 1997 (gm/m <sup>3</sup> )	ERPG-2 1991 (gm/m <sup>3</sup> )	ERPG-2 2002 (gm/m <sup>3</sup> )	LC <sub>50</sub> / 10 (gm/m <sup>3</sup> )	$LC_{LO}$ / $10$ $(gm/m^3)$							
Phenol	Г	Expert judgement	0.963							94.1	181.7	0.074	13.023	4.5 (10,000)	9.10 (20,000)	Raise TQ to 9.1 t (20,000 lbs) based on IDLH (1990)
Stibine	G	Expert judgement	0.204							124.8	-18.3	1.000	0.204	0.22 (500)	2.27 (5,000)	Raise TQ to 2.27 t (5,000 lbs) based on IDLH (1990)
Tetraethyl lead	L	Expert judgement	0.040							323.4	108.9	0.197	0.226	1.0 (2,200)	2.27 (5,000)	Raise TQ to 2.27 t (5,000 lbs) based on IDLH (1990)
Thionyl chloride	L	Expert judgement						0.244 <sup>5</sup>		119.0	76.1	0.113	2.161	0.1 (220)	6.8 (15,000)	Raise TQ to 6.8 t (15,000 lbs) based on RTEC LC 50 1 hour (500 ppm) divided by 10
Trioxychlorofluoride	G	Expert judgement			0.419 <sup>6</sup>					102.5	-46.7	1.000	0.419	2.2 (5,000)	6.8 (15,000)	Raise TQ to 6.8 t (15,000 lbs) based on IDLH (1990)
Notes																
1: ERPG-2 (1991)																
2: LC <sub>b</sub> 10 min NTP Chemical Repositry 13 Aug. 2001 divided by 10 3: IDLH (1994)																
4: IDLH (1994)																
5: LC <sub>50</sub> 1 h (500 ppm) RTEC July 2000 divided by 10 6: IDLH (1997)																

# Physical States:

L = liquid

G = gas S = solid

# APPENDIX A

NFPA 704 STANDARD SYSTEM FOR THE IDENTIFICATION OF THE HAZARDS OF MATERIALS FOR EMERGENCY RESPONSE 2001 EDITION

Appendix A NFPA 704 - Standard System for the Identification of the Hazards of Materials for Emergency  $Response^{15}$ 

Health Hazards	Fire Hazards	Instability Hazards
4	4	4
Materials that, under emergency	Materials that will rapidly or completely	Materials that in themselves are
conditions, can be lethal. The following	vaporize at atmospheric pressure and	readily capable of detonation or
criteria shall be considered when rating	normal ambient temperature or that are	explosive decomposition or explosive
materials:	readily dispersed in air, and which will	reaction at normal temperatures and
Gases whose LC <sub>50</sub> for acute inhalation	burn readily. This includes:	pressures. This includes materials
toxicity is less than or equal to 1,000	Flammable gases;	that are sensitive to localized thermal
parts per million (ppm);	Flammable cryogenic materials;	or mechanical shock at normal
Any liquid whose saturated vapor	Any liquid or gaseous material that is	temperatures and pressures.
concentration at 68°F (20°C) is equal to	liquid while under pressure and has a flash	Materials that have an
or greater than ten times its LC <sub>50</sub> for acute	point below 73°F (22.8°C) and a boiling	instantaneous power density
inhalation toxicity, if its LC <sub>50</sub> is less than	point below 100°F (37.8°C) (i.e., Class IA	(product of heat of reaction and
or equal to 1,000 parts per million (ppm);	liquids);	reaction rate) at 482°F (250°C) of
Dusts and mists whose LC <sub>50</sub> for acute	Materials that ignite spontaneously	1,000 W/mL or greater.
inhalation toxicity is less than or equal to	when exposed to air.	
0.5 milligrams per liter (mg/L);		
Materials whose LD <sub>50</sub> for acute dermal		
toxicity is less than or equal to 40		
milligrams per kilogram (mg/kg);		
Materials whose LD <sub>50</sub> for acute oral		
toxicity is less than or equal to 5		
milligrams per kilogram (mg/kg).		

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<sup>&</sup>lt;sup>15</sup> NFPA 704, National Fire Protection Association, Quincy, MA, U.S.A.

Materials that, under emergency conditions, can cause serious or permanent injury.

Gases whose  $LC_{50}$  for acute inhalation toxicity is greater than 1,000 ppm but less than or equal to 3,000 ppm.

Any liquid whose saturated vapor concentration at  $20^{\circ}C$  ( $68^{\circ}F$ ) is equal to or greater than its  $LC_{50}$  for acute inhalation toxicity, if its  $LC_{50}$  is less than or equal to 3,000 ppm and that does not meet the criteria for degree of hazard 4.

Dusts and mists whose  $LC_{50}$  for acute inhalation toxicity is greater than 0.5 mg/L but less than or equal to 2 mg/L.

Materials whose  $LD_{50}$  for acute dermal toxicity is greater than 40 mg/kg but less than or equal to 200 mg/kg.

Materials that are corrosive to the respiratory tract.

Materials that are corrosive to the eye or cause irreversible corneal opacity.

Materials that are corrosive to skin.

Cryogenic gases that cause frostbite and irreversible tissue damage.

Compressed liquefied gases with boiling points at or below -55°C (-66.5°F) that cause frostbite and irreversible tissue damage.

Materials whose  $LD_{50}$  for acute oral toxicity is greater than 5 mg/kg but less than or equal to  $LD_{50}$  mg/kg.

3

Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions.

Liquids having a flash point below 22.8°C (73°F) and having a boiling point at or above 37.8°C (100°F) and those liquids having a flash point at or above 22.8°C (73°F) and below 37.8°C (100°F) (i.e., Class IB and Class IC liquids).

Materials that on account of their physical form or environmental conditions can form explosive mixtures with air and that are readily dispersed in air. Flammable or combustible dusts with representative diameter less than 420 microns (40 mesh).

Materials that burn with extreme rapidity, usually by reason of self-contained oxygen (e.g., dry nitrocellulose and many organic peroxides).

Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent. 3

Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction, but that require a strong initiating source or that must be heated under confinement before initiation.

Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 100 W/mL and below 1,000 W/mL.

Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.

Gases whose  $LC_{50}$  for acute inhalation toxicity is greater than 3,000 ppm but less than or equal to 5,000 ppm.

Any liquid whose saturated vapor concentration at  $20^{\circ}\text{C}$  (68°F) is equal to or greater than one-fifth its LC<sub>50</sub> for acute inhalation toxicity, if its LC<sub>50</sub> is less than or equal to 5,000 ppm and that does not meet the criteria for either degree of hazard 3 or degree of hazard 4.

Dusts and mists whose  $LC_{50}$  for acute inhalation toxicity is greater than 2 mg/L but less than or equal to 10 mg/L.

Materials whose  $LD_{50}$  for acute dermal toxicity is greater than 200 mg/kg but less than or equal to 1,000 mg/kg.

Compressed liquefied gases with boiling points between -30°C (-22°F) and -55°C (-66.5°F) that can cause severe tissue damage, depending on duration of exposure.

Materials that are respiratory irritants. Materials that cause severe but reversible irritation to the eyes or lacrimators.

Materials that are primary skin irritants or sensitizers.

Materials whose  $LD_{50}$  for acute oral toxicity is greater than 50 mg/kg but less than or equal to 500 mg/kg.

2

Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air.

Liquids having a flash point at or above 37.8°C (100°F) and below 93.4°C (200°F) (i.e., Class II and Class IIIA liquids).

Solid materials in the form of powders or coarse dusts of representative diameter between 420 microns (40 mesh) and 2 mm (10 mesh) that burn rapidly but that generally do not form explosive mixtures with air.

Solid materials in a fibrous or shredded form that burn rapidly and create flash fire hazards, such as cotton, sisal, and hemp.

Solids and semisolids that readily give off flammable vapors.

Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent. 2

Materials that readily undergo violent chemical change at elevated temperatures and pressures.

Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 10 W/mL and below 100 W/mL.

Materials that, under emergency conditions, can cause significant irritation.

Gases and vapours whose  $LC_{50}$  for acute inhalation toxicity is greater than 5000 ppm but less than or equal to 10,000 ppm.

Dusts and mists whose  $LC_{50}$  for acute inhalation toxicity is greater than 10 mg/L but less than or equal to 200 mg/L.

Materials whose LD $_{50}$  for acute dermal toxicity is greater than 1000 mg/kg but less than or equal to 2,000 mg/kg.

Materials that cause slight to moderate irritation to the respiratory tract, eyes, and skin.

Materials whose LD $_{50}$  for acute oral toxicity is greater than 500 mg/kg but less than or equal to 2,000 mg/kg.

1

Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur.

Liquids with a flash point greater than 35°C (95°F) that do not sustain combustion when tested using the Method of Testing for Sustained Combustibility, per 49 CFR 173, Appendix H or the UN Recommendations on the Transport of Dangerous Goods, Model Regulations, 11th revised edition, and the related Manual of Tests and Criteria, 3rd revised edition.

Liquids with a flash point greater than 35°C (95°F) in a water-miscible solution or dispersion with a water noncombustible liquid/solid content of more than 85 percent by weight.

Liquids that have no fire point when tested by ASTM D 92, Standard Test Method for Flash and Fire Points by Cleveland Open Cup, up to the boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change. Combustible pellets with a representative diameter greater than 2 mm (10 mesh).

Most ordinary combustible materials.

Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent.

1

Materials that in themselves are normally stable, but that can become unstable at elevated temperatures and pressures.

Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 0.01 W/mL and below 10 W/mL.

Materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials. Gases and vapors whose  $LC_{50}$  for acute inhalation toxicity is greater than 10,000 ppm.

Dusts and mists whose  $LC_{50}$  for acute inhalation toxicity is greater than 200 mg/L.

Materials whose LD $_{50}$  for acute dermal toxicity is greater than 2,000 mg/kg. Materials whose LD $_{50}$  for acute oral toxicity is greater than 2,000 mg/kg. Materials that are essentially nonirritating to the respiratory tract, eyes, and skin.

0

Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand.

Materials that will not burn in air when exposed to a temperature of 816°C (1,500°F) for a period of 5 minutes.

0

Materials that in themselves are normally stable, even under fire conditions.

Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) below 0.01 W/mL.

Materials that do not exhibit an exotherm at temperatures less than or equal to 500°C (932°F) when tested by differential scanning calorimetry.

# APPENDIX B

TECHNICAL DETAILS FOR DETERMINATION OF THRESHOLD PLANNING QUANTITIES UNDER EPA RISK MANAGEMENT PROGRAM

Appendix B Technical Details for Determination of Threshold Planning Quantities Under EPA Risk Management Program

This Appendix is extracted from Federal Register/ Vol. 51, No. 221 / Monday November 17, 1986 page 41580.

Physical state and volatility were used to derive an index of the chemical's potential to become airborne and disperse. The two indices were combined to produce an overall risk "ranking factor" defined as:

Index = Level of concern/V,

Where: Level of concern = IDLH; IDLH is the Immediate concentration dangerous for life and health

published in 1990 by NIOSH, alternative level of concern where used when IDLH 1990 was not available for a specific substance, see page 19;

and,

V = index of potential to become airborne and disperse.

For gases and solids V equals 1.000, meaning all chemical once released can be potentially airborne. For liquids, V is calculated by estimating the rate of volatilization (mass vaporized per unit of time) per mass of liquid spilled. The V may be generated as follows using equations from Clements (1981) (see also TRC, 1986).

The evaporation rate of a liquid into stagnant air may be estimated by:

$$G = (1.74 \times 10^{-4} \text{MKAP}) / (\text{RT})$$

Where: G = Generation rate (pounds/minute);

M = Molecular weight (grams/mole);

K = Mass transfer coefficient (cm/sec);

A = Surface area of spill (cm<sup>2</sup>);

P = Vapour pressure of the chemical (mm Hg);

R = Universal gas constant (82.05 (atm x cm<sup>3</sup>) / (g-mole x  $^{\circ}$ K)); and,

 $T = Temperature of the liquid (<math>{}^{\circ}K$ )

mass transfer coefficient may be approximated by referencing the unknown chemical to water.

$$K = 0.83(18/M)^{0.33}$$

Combining equations gives:

$$G = (3.78 \times 10^{-4} \text{M}^{2/3} \text{AP})/\text{RT}$$

The surface area of a spill (or pool) is primarily a function of spilled quantity, provided the spill occurs on a flat non absorbing surface. The depth of the pool is assumed to be 1 cm, although if the area around a storage vessel is diked or not flat where puddling could take place, deeper levels could occur for the same surface area of spilled material. In the absence of specific information about the size of diked area for each liquid, we assume that the spill is 1 cm deep and has a density about that of water (1gm/cm³);

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Area (cm<sup>2</sup>) = 
$$454 \text{ (gm/lb)} \times Q \text{ (lb)} / \text{ ( (gm/cm3)} \times \text{ ( 1 cm)}$$
)  
=  $454 \text{ O}$ 

Where: Q = Mass of liquid spilled (pounds)

Substituting and assuming the liquid is at its boiling temperatures (P = 760 mm Hg) T > boiling point:

$$G/Q = V = 1.6 M^{0.67} / (T+273)$$

Where *G/Q* represents the rate of volatilization per mass of spilled liquid. Note that V was estimated for liquids at their boiling point rather than at ambient temperatures. Conditions during accidental releases are likely to vary and involve heat (e.g. fires, exothermic runaway reactions or reactions with air or water) causing more rapid volatilization of the liquid. EPA recognizes that spills at ambient temperatures are also likely and that the rate of volatilization may be impacted by heat from surroundings, subcooling due to evaporation and flashing from superheated conditions. However, for purposes of developing a relative ranking between substances volatilization at boiling points was utilized and consideration of other conditions for all chemicals is not expected to greatly reorder the ranking of chemicals.

#### References

TRC 1986. "Evaluation and Assessment of Models for Emergency Response Planning prepared for CMA", TRC Environmental Consultants, Inc. April 1986.

Clements, 1981. "Mathematical Models for Estimating Workplace Concentration Levels: A Literature Review" U.S.EPA, Clement Associates, 1981.

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# **APPENDIX C**

# TOXIC SUBSTANCES RANKING FACTORS USED TO ASSIGN THRESHOLDS AND RELATED DATA

(LISTED IN ORDER OF RANKING FACTOR)

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Appendix C Toxic Substances Ranking Factors Used to Assign Thresholds and Related Data (Listed in Order of Ranking Factor)

This Appendix presents the toxic substances ranking used to assign threshold quantities in the current RMP list.

CAS No.	Chemical Name	Ambient	Level of	Basis	Molecular	U	Ranking	Threshold
		Physical State	Concern (LOC)	for LOC	Weight	Point (°C)	Factor	(lbs)
		State	$g/m^3$ )	Loc				
107-02-8	Acrolein	Liquid	0.011	IDLH	56.06	52.50	0.157	5,000
107-13-1	Acrylonitrile	Liquid	1.096	IDLH	53.60	77.30	16.658	20,000
814-68-6	Acrylyl chloride	Liquid	0.009	Tox	90.51	75.00	0.096	5,000
107-18-6	Allyl alcohol	Liquid	0.356	IDLH	58.09	97.00	5.421	15,000
107-11-9	Allylamine	Liquid	0.066	Tox	57.09	55.00	0.900	10,000
7664-41-7	Ammonia (anhydrous)	Gas	0.348	IDLH	17.03	-33.35	0.348	10,000
7664-41-7	Ammonia (aqueous solution conc 20% or greater)	Solution	0.348	IDLH	17.03	based on vapour pressure of solution	7.88045	20,000
7784-42-1	Arsine	Gas	0.019	IDLH	77.93	-62.50	0.019	1,000
10294-34-5	Boron trichloride	Gas	0.100	Tox	117.20	12.5	0.100	5,000
7637-07-2	Boron trifluoride	Gas	0.277	IDLH	67.82	-100.40	0.277	5,000
353-42-4	Boron trifluoride compound with methyl ether 1:1	L	0.233	Tox	113.89	126	2.434	15,000
7726-95-6	Bromine	Liquid	0.065	IDLH	160.00	60.00	0.454	10,000
75-15-0	Carbon disulfide	Liquid	1.560	IDLH	76.13	46.50	17.113	20,000
7782-50-5	Chlorine	Gas	0.087	IDLH	70.91	-34.05	0.087	2,500
10049-04-4	Chlorine dioxide	Solution	0.027	IDLH	67.45	Treated as gas at ambient conditions	0.028	1,000
67-66-3	Chloroform	Liquid	4.883	IDLH	119.39	61.70	42.126	20,000
542-88-1	Bis(chloromethyl) ether	Liquid	0.002	Tox	114.97	106.00	0.025	1,000
107-30-2	Chloromethyl methyl ether	Liquid	0.018	Tox	80.52	59.00	0.200	5,000
4170-30-3	Crotonaldehyde	Liquid	1.160	IDLH	70.10	104.00	15.851	20,000
123-73-9	Trans-Crotonaldehyde	Liquid	1.160	IDLH	70.10	104.00	15.851	20,000
506-77-4	Cyanogen chloride	Gas	0.300	Tox	61.47	13.80	0.300	10,000
108-91-8	Cyclohexylamine	Liquid	1.560	Tox	99.17	134.50	18.262 <sup>1</sup>	15,000 <sup>1</sup>
19287-45-7	Diborane	Gas	0.050	IDLH	27.69	-92.50	0.050	2,500
75-78-5	Dimethyldichlorosilane	Liquid	0.030	Tox	129.07	70.00	0.248	5,000
57-14-7	1,1-Dimethylhydrazine	Liquid	0.123	IDLH	60.10	63.90	1.665	15,000
106-89-8	Epichlorohydrin	Liquid	0.962	IDLH	92.53	116.50	11.276	20,000
75-21-8	Ethylene oxide	Gas	1.440	IDLH	4406	10.70	1.440	10,000
107-15-3	Ethylenediamine	Liquid	4.900	IDLH	60.12	116.00	76.574	20,000
151-56-4	Ethyleneimine	Liquid	0.040	Tox	43.07	55.00	0.725	10,000
7782-41-4	Fluorine	Gas	0.039	IDLH	38.00	-188.13	0.039	1,000
50-00-0	Formaldehyde (solution)	Solution	0.037	IDLH	30.03	-19.00	0.037	15,000
110-00-9	Furan	Liquid	0.012	Tox	68.08	32.00	0.135	5,000
302-01-2	Hydrazine	Liquid	0.105	IDLH	32.05	113.50	2.485	15,000
7647-01-0	Hydrochloric acid (solution conc 37% or greater) <sup>2</sup>	Solution	0.150	IDLH	36.46	based on vapour pressure of solution	1.60294	15,000

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CAS No.	Chemical Name	Ambient Physical State	Level of Concern (LOC) g/m³)	Basis for LOC	Molecular Weight	Boiling Point (°C)	Ranking Factor	Threshold (lbs)
7664-39-3	Hydrofluoric acid (conc 50% or greater)	Solution	0.0240	IDLH	20.01	19.51	0.024	1,000
74-90-8	Hydrogen cyanide	Gas	0.055	IDLH	27.03	25.60	0.055	2,500
7547-01-0	Hydrogen chloride (anhydrous)	Gas	0.150	IDLH	36.46	-85.00	0.150	5,000

CAS No.	Chemical Name	Ambient Physical State	Level of Concern (LOC) g/m3)	Basis for LOC	Molecular Weight	Boiling Point (oC)	Ranking Factor	Threshold (lbs)
7664-39-3	Hydrogen fluoride, anhydrous	Gas	0.0245	IDLH	20.01	19.51	0.024	1,000
7783-07-5	Hydrogen selenide	Gas	0.007	IDLH	80.98	-41.30	0.007	500
7783-06-4	Hydrogen sulphide	Gas	0.420	TLV	34.08	-60.33	0.420	10,000
13463-40-6	Iron pentacarbonyl	Liquid	0.008	TLV	195.90	103.00	0.055	2,500
78-82-0	Isobutyronitrile	Liquid	2.820	Tox	69.10	103.80	38.886	20,000
108-23-6	Isopropyl chloroformate	Liquid	1.000	Tox	122.55	104.60	9.413	15,000
126-98-7	Methacrylonitrile	Liquid	0.030	TLV	67.10	90.30	0.407	10,000
74-87-3	Methyl chloride	Gas	21.000	IDLH	50.49	-24.00	$21.000^3$	10,000
79-22-1	Methyl chloroformate	Liquid	0.018	Tox	94.50	71.00	0.189	5,000
60-34-4	Methylhydrazine	Liquid	0.096	IDLH	46.07	87.50	1.662	15,000
624-83-9	Methyl isocyanate	Liquid	0.047	IDLH	57.05	39.00	0.618	10,000
74-93-1	Methyl mercaptan	Gas	0.787	IDLH	48.11	5.95	0.787	10,000
556-64-9	Methyl thiocyanate	Liquid	0.850	Tox	73.12	130.00	12.070	20,000
75-79-6	Methyltrichlorosilane	Liquid	0.018	Tox	149.5	66.5	0.133	5,000
13463-39-3	Nickel carbonyl	Liquid	0.007	Tox	170.73	43.00	0.042	1,000
7697-37-2	Nitric acid (conc 80% or greater)	Liquid	0.258	IDLH	63.01	83.00	3.576	15,000
10102-43-9	Nitric oxide	Gas	0.300	TLV	30.01	-151.70	0.300	10,000
8014-95-7	Oleum (fuming sulphuric acid)	Liquid	0.030	IDLH	80.06	45	0.316	10,000
79-21-0	Peracetic acid	Liquid	0.045	Tox	76.05	105.00	0.584	10,000
594-42-3	Perchloromethyl mercaptan	Liquid	0.076	IDLH	185.90	147.00	0.602	10,000
75-44-5	Phosgene	Gas	0.008	IDLH	98.92	8.20	0.008	500
7803-51-2	Phosphine	Gas	0.278	IDLH	34.00	-87.70	0.278	5,000
10025-87-3	Phosphorus oxychloride	Liquid	0.030	Tox	153.30	106.00	0.244	5,000
7719-12-2	Phosphorus trichloride	Liquid	0.280	IDLH	137.40	76.00	2.256	15,000
110-89-4	Piperidine	Liquid	0.224	Tox	85.15	106.00	2.701	15,000
107-12-0	Propionitrile	Liquid	0.037	Tox	55.08	97.20	0.584	10,000
109-61-5	n-Propyl chloroformate	Liquid	0.100	Tox	122.60	114.00	0.965	15,000 <sup>4</sup>
75-56-9	Propylene oxide	Liquid	4.840	IDLH	58.08	34.23	61.135 <sup>3</sup>	10,0003
75-55-8	Propyleneimine	Liquid	1.180	IDLH	57.11	66.00	16.633	10,0005
7446-09-5	Sulphur dioxide	Gas	0.262	IDLH	64.07	-10.00	0.262	5,000
7783-60-0	Sulphur tetrafluoride	Gas	0.080	Tox	108.10	-40.00	0.080	2,500
7446-11-9	Sulphur trioxide	Liquid	0.030	Tox	80.06	45.00	0.316	10,000
75-74-1	Tetramethyl lead	Liquid	0.040	IDLH	267.30	110.00*	0.226	10,000
509-14-8	Tetranitromethane	Liquid	0.080	TLV	196.00	126.00	0.581	10,000
7550-45-0	Titanium tetrachloride	Liquid	0.010	Tox	189.70	136.40	0.076	2,500
584-84-9	Toluene-2,4-diisocyanate	Liquid	0.072	IDLH	174.20	251.00	0.573	10,000
91-08-7	Toluene-2,6-diisocyanate	Liquid	0.072	IDLH	174.20	129.00*	0.573	10,000
26471-62-5	Toluene diisocyanate (unspecified isomer)	Liquid	0.022	IDLH	174.20	251.00 (based on 2,4- isomer)	0.573	10,000
75-77-4	Trimethylchlorosilane	Liquid	0.500	Tox	108.70	57.00	4.457 <sup>6</sup>	10,0006
108-05-4	Vinyl acetate monomer	Liquid	0.540	Tox	86.09	72.00	5.884	15,000

\* Boiling point at reduced pressure; estimated value for atmospheric pressure used in calculation

\*\* References:

National Institute for Occupational Safety and Health (NIOSH), *Pocket Guide to Chemical Hazards*, 1990 edition.

NIOSH, Registry of Toxic Effects of Chemical Substances (RTECS), on-line database, December, 1990.

U.S. Environmental Protection Agency, Federal Emergency Management Agency, U.S. Department of Transportation, *Technical Guidance for Hazards Analysis, Emergency Planning for Extremely Hazardous Substances*, December, 1987.

U.S. Environmental Protection Agency, *EPA Chemical Profiles for Extremely Hazardous Substances*, June 1988.

- 1 Index incorrectly calculated in RMP as 1.27195
- 2 New recommended concentration 30% or greater based on vapour pressure of solution
- 3 Chemical is flammable and defaults to a TQ of 10,000.
- 4 Possibly bumped to next bin due to rounding
- 5 RMP Ranking Factor calculated as 16.633 but given 10,000 as TQ
- 6 RMP Ranking Factor incorrectly calculated as 0.906