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# A risk management initiative implemented in Canada

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**Abstract**

This paper describes recent initiatives in Canada that lead to a new regulation on environmental emergencies under the Canadian Environmental Protection Act of 1999. The regulation includes a list of hazardous substances with threshold quantities. It has requirements for prevention, preparedness, response and recovery. The regulation is based on voluntary guidelines developed by industry, public authorities, municipalities and representatives of the public. The guidelines are a reference for industry and municipalities to help them manage risk related to major industrial accidents. The guidelines released in July 2002 are innovative in the sense that municipalities are strongly involved in the risk management process through the creation of Local Emergency Planning Committees (Joint Committees) with representatives from industry, municipalities and public. This work appears as a relevant approach to involve the public in the decision-making process and makes people aware of the hazards and the measures taken to control risk.


*Keywords:* Environmental emergency regulation; List of hazardous substances; Guidance; Public participation

## 1. Introduction

Instead of legislating after the Bhopal accident, Canada chose to innovate by adopting a consultative approach. In 1987, Environment Canada has set up the Major Industrial Accident Council of Canada (MIACC), a non-profit organization financed by the federal and provincial governments and industry. MIACC was viewed by the stakeholders as an alternative to a legislative and regulatory approach exclusively directed by governments.

MIACC was a process rather than a structure. Governments, industries, responders, trade unions, non-governmental organizations (NGOs), etc. have shared their expertise. It has worked as a partnership for the development of standards, guidance documents, etc. in prevention, preparedness, response and recovery.

MIACC was based on the Canadian Chemical Producers Association (CCPA) *Responsible Care*™ initiative. MIACC strength was its process to build strong consensus.

This partnership is very important. It is the cornerstone of the approach that followed.

MIACC ceased to exist in 1999 because of administrative problems. Although, MIACC disappearance is unfortunate, it is not dramatic. A culture of partnership, of working together towards common objectives, is now well in place and influences the development of regulations. Two examples are analysed to illustrate this point:

- Canadian Chemical Producers Association *Responsible Care*™ Risk Communication;
- East Montreal Local Emergency Planning Committee.

## 2. CCPA guidance for site risk communication

CCPA provided Guidance intended to help members understand better the expectations of *Responsible Care*™ regarding site risk communication.

Site risk communication is probably best considered from three aspects:

(a) understanding what the hazards and risks are in the first place, then getting them under proper control;
(b) advising and assisting responders in ensuring that the community is appropriately prepared;

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(c) soliciting and demonstrating sensitivity and responsiveness to community concerns via some form of dialogue process.

The result is a protected, informed community, having both an awareness of the chemical industry's presence and a reasonable comfort level that hazards and risks are under competent control.

### 2.1. Risk assessment and management obligations under *Responsible Care*™

It is essential to know and understand what could go wrong at each sites where hazardous substances are handled and what are the off-site implications. The knowledge of who could be affected and what those effects might be is essential for community preparedness [1].

The guidance stress the need to consider what could go wrong rather than what is expected to go wrong, because of the danger of overlooking hazards whose significance is not obvious. The result should be a range of scenarios describing potential incidents according to their possible consequences rather than their causes.

The first guiding principle of *Responsible Care*™ then requires action to correct any situation posing "an unacceptable level of risk to employees, the public or the environment".

Control measures should then be put in place to ensure that risks of release, etc. are kept within the established limits or better still, further improved. Mitigation measures should also be used to reduce the effects of any incident which does occur.

### 2.2. Prevention is not enough

The above activities focus on prevention and in a perfect world, the story would end there. In reality, however, incidents cannot be entirely prevented. Despite the tremendous improvements made under *Responsible Care*™, serious incidents or near-misses are still experienced. Since 1986, in both Canada and the U.S., chemical site managers have been committed via community awareness and emergency response (CAER) to inform neighbouring communities of hazards and risks arising from their operations and to do their utmost to ensure that appropriate preparedness measures are in place should such a situation ever occur [2].

### 2.3. Technical risk assessment basis for CCPA members

CCPA's process safety management committee was asked to look at the technical basis for defining accident scenarios and came up with two base cases. Their application is explained below.

#### 2.3.1. Worst case scenario

This is the worst that could conceivably occur, but goes beyond what the community could reasonably be expected to plan for. The worst case scenario is most relevant in demonstrating that the company has indeed considered everything before coming up with what it considers to be the credible worst cases or alternate case scenarios.

#### 2.3.2. Alternate case scenarios

"Do not tell me all the things that might happen – tell me what to plan for" is a typical viewpoint of emergency responders, as expressed during discussions on worst case scenarios. The alternate case scenario is just that: a scenario that is not expected to happen, but which nonetheless is something which should be taken into account, when developing community emergency plans.

Emergency plans and prevention measures inside the site should of course not only consider the alternate case scenario, but also the range of scenarios which could occur up to and including the worst case (it makes no sense to avoid discussing tank trucks of flammable liquid with the community, simply because there is a large LPG sphere on the site). Most of these less critical scenarios, by their very nature, will be more frequent than the worst case and are likely to feature more prominently in the community's experience of the company.

### 2.4. Communicating with the community

There are two primary aspects to communicating with the community.

The first is to ensure that all those who may need to take action to protect themselves and others, in the event of an incident, are aware and prepared. This obviously applies to responders and community officials, but it will also affect members of the public if they may be called on to shelter inside or to evacuate the area. They need to be informed about what to expect, for example, who will tell them what to do when emergency action is needed and how will this be communicated.

The second aspect involves identifying and responding to community concerns. It goes well beyond the previous aspect, but should build on it rather than being viewed as a separate item.

### 2.5. Emergency preparedness: responders have a broader scope

So far, site risks, including "worst case", have been discussed entirely from the site viewpoint. For responders, however, the worst case may involve a natural disaster or perhaps a hazardous materials incident arising from some other site, from materials being transported through the community or possibly even from a malicious act such as sabotage or mischief.

Even where your site is concerned, responders may agree with the site interpretation of credible worst case and range of likely scenarios or they may not. Differences of opinion should be considered carefully to ensure that all valid points have indeed been taken into account.

Build relationships before you need them, communication with responders and others enables the company to build working relationships well in advance of a possible emergency. These relationships normally strengthen through the company's "advise and assist" role through the development and testing of community emergency plans. The company should persist until satisfied that community preparedness is at an acceptable level.

### 2.6. *Demonstrating sensitivity and responsiveness to community concerns*

When it comes to the public, it is most important to recognize that the company's worst case may not be the worst case from the view of the public or of individuals in the community and may even be irrelevant to them. Whether or not the community responders agree with the company's worst case is probably not significant, because responders consider what is in the interests of the community as a whole and in comparison with other communities. The public reference point is much more likely to be an individual one and this can make a big difference.

#### 2.6.1. *They may be right!*

These viewpoints are not necessarily wrong—a mother's concern over the risk of a truck accident involving her child may justifiably be higher than that over a fire or toxic gas release. It is just that they are individual viewpoints and are more difficult to address than the usual interpretation of worst case, because you need to talk to the individual first, before you have an idea of what the real concerns are.

#### 2.6.2. *Work through community responders*

When it comes to telling the public about site risks and worst case scenarios, it is usually best if this is done with the involvement of the designated community emergency officials, wherever possible. They can present the situation in perspective and tell what individuals need to know about the public alert system, sheltering procedures and evacuation routes. It is important to work with the community officials, where possible.

#### 2.6.3. *Follow-up to find out about individual concerns*

The company can then follow-up with its own dialogue process to find out what concerns are out there in addition to those covered by the community emergency plan. The range of hazards and risks from the site, including the worst case scenarios the alternate case scenarios, together with a selection from the host of lesser events identified, can also be addressed, since by now, the public will have the context provided by the community officials and the CAER committee.

### 2.7. *Involve your Local Emergency Planning Committee in planning how to communicate*

Involving members of the Local Emergency Planning Committee (LEPC) or participants in any other form of advisory process in developing plans for communicating to the community at large is likely to be well worthwhile (not doing so is hardly the way to build the image of an open, caring involvement process).

Look upon community dialogue as a continuing process. The situation can change much faster with individual concerns than with site hazards, where site management is more aware of developments, as they occur. This is why community dialogue should be an ongoing process, to an even greater extent, than community emergency planning.

## 3. An initiative example: East Montreal Local Emergency Planning Committee

With the experience of MIACC and CCPA initiatives, communities from East Montreal have developed a protocol for management of hazardous substance [3]. This document was elaborated to assist establishments where hazardous substances are used to:

- define the inventory of hazardous substances they hold;
- analyse the methods for production, storage and use of these substances;
- analyse the impact of an accident involving these substances; in order to,
- put in place preventive measures;
- elaborate emergency plans to intervene efficiently if an accident happens;
- provide information to the public to ensure their safety.

Fig. 1 presents the process that is followed.

The Risk Management Guide for major industrial accidents intended for municipality and industry is the foundation for the Environmental emergency regulation under the Canadian Environmental Protection Act of 1999.

## 4. Environmental emergency regulation

For those organizations having to prepare environmental emergency plans under either sections 199 or 200, Part 8 of CEPA 1999 requires that prevention, preparedness, response and recovery aspects be addressed [4]. The concepts associated with these four main elements are provided in the following sections. Appendix A gives the list of regulated substances and their threshold quantities.

### 4.1. *Prevention*

The likelihood of environmental emergency events can be reduced by identifying in advance the frequency, potential consequences and impacts of such events. The prevention of such emergencies includes several components, the most important being the knowledge gained from evaluating the risks associated with the substance(s) of concern. As most incidents leading to an emergency are caused by deviations

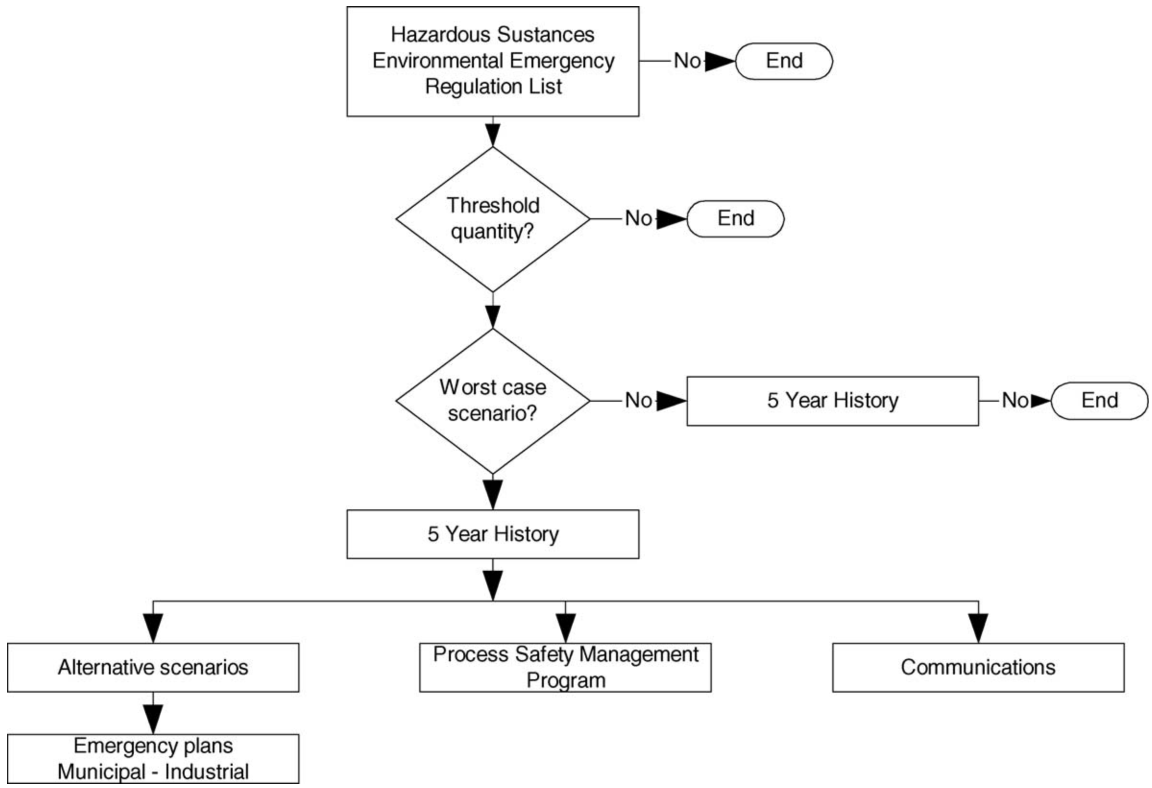


Fig. 1. Risk management program.

from normal conditions within a facility, the evaluation of past emergency events occurring at the site and at other similar facilities and the range of potential scenarios, including worst case and alternate cases, is critical to understanding a facility's capabilities and resources in the event of a crisis. This does not imply planning for every imaginable worst case scenarios, as this is not practical, however, the plan should address those alternate cases and other scenarios that may be credible.

The key to reducing the frequency and severity of environmental emergency events is preventing them from happening in the first place. The most effective risk management actions combine prevention activities with appropriate preparedness and response. Case histories have shown that it is much more cost effective to implement an appropriate risk management program in advance than to repair any resulting damage done to the facility or to the environment after the fact. Prevention activities also have the significant benefit of providing evidence of "due diligence", thereby, lessening the likelihood of prosecution following an emergency. With preventive action, problems can be anticipated, corrective action can be taken and risks can be managed to avoid environmental damage. Prevention refers not only to mitigation measures, such as maintenance and spill containment, but also to the management systems for design and operation and to ensuring that the facility operates as intended.

For process industries in Canada, the application of management principles and systems to the identification, understanding and control of process hazards to prevent process-related injuries and accidents is referred to as process safety management. The programs are designed to address key elements of process safety management, such as:

- risk assessment;
- facility design and construction to specific standards;
- preventive maintenance checks and programs;
- effective operating procedures and facility documentation;
- operator competence assurance;
- process and procedures to ensure that changes in design or service or staff are effectively managed and to minimize impacts on operations;
- incident investigation and analysis to minimize recurrence;
- assessment of compliance to standards.

Typically, issues, such as process risk management, management of change and management of human factors, among others, are documented and complement traditional health and safety programs and applicable legislation. A complete framework of process safety management elements is recommended, even though some elements may be less applicable than others, depending on the nature and degree of potential hazards involved. Each element should be considered before assuming it is not applicable.

### 4.2. Preparedness

Effective preparedness for environmental emergencies is built on trust and co-operation among industry, all levels of government and the community. Through working together, they must accomplish the following:

- identify potential risks;
- document alternative scenarios and potential consequences;
- develop environmental emergency plans to deal with the risks;
- train personnel to apply the environmental emergency plans;
- conduct regular review and practise these strategies.

To enhance the level of preparedness, key people, including representatives of key stakeholder groups in and around the facility who may be affected, should be involved with the development and implementation of the environmental emergency plan, particularly, first responders.

A facility must identify whether adequate capabilities and resources exist to enable those involved to safely respond to the full range of potential emergencies. Identified gaps should be filled, equipment should be upgraded, staff should be expanded and there should be increased communication between neighbouring facilities, community officials, public safety agencies, etc. Preparedness measures should identify all activities essential to ensuring a high degree of readiness for a prompt and effective response to an environmental emergency. Periodic drills and exercises as well as effective training for key personnel in and around the facility provide the means of testing the facility's resources and equipment and also raise awareness. Equipment needed during an emergency should be readily available and regularly maintained and tested. An inventory of equipment currently available on and off the site, along with the quantity, location, description, intended use and capabilities, must be retained and accessible to responders. An emergency plan must be regularly reviewed to ensure that changes within the facility are integrated into the plan. By implementing effective prevention measures (such as risk management programs that address all possible emergency situations), persons preparing and implementing an environmental emergency plan can determine the necessary level of preparedness for each situation.

### 4.3. Response

Response to an environmental emergency includes many facets, such as maintaining communication systems between stakeholders, alerting and warning affected parties and if needed, evacuating and accounting for personnel and the public. These needs can vary greatly in scope, depending on the nature and magnitude of the emergency. Quick and effective response relies on sound planning and pre-established partnerships. Effective emergency response calls for co-operation between industries, communities, local organizations and government through partnerships formed before emergencies occur. Such partnerships can be strengthened through the regular exercise of the environmental emergency plan with all of those involved. Communication from the facility to off-site agencies and between responders is important and necessary for a coordinated and successful response effort. Effective emergency response includes, but is not limited to, quick activation of the emergency plan, proper notification of the emergency to first responders and affected parties, rapid assessment of the probable path and impacts of an emergency, adequate resource mobilization and reporting activities. Response is intended to include all aspects of managing an emergency situation, until the emergency phase of the event is considered over.

### 4.4. Recovery

Recovery refers to the restoration of any part of the environment damaged by or during the emergency. Recovery affects both the operating entity itself and the surrounding community. The issue of recovery is best managed through discussions between all involved parties to assess the damage and agree on a restoration plan. Restoration plans are situation specific and would need to be defined in terms of acceptability to affected stakeholders. The responsible party would, in accordance with the "polluter pays" principle, be given the opportunity to execute a restoration plan.

Recovery from an environmental emergency involves activities and programs designed to return the facility and its surrounding environment to a safe and acceptable condition. The general objective of the recovery portion of an environmental emergency plan should be to provide sufficient direction to reduce impacts to the environment and to minimize the recovery time from a particular incident.

The responsible party and public authorities should initiate recovery processes as soon as possible, striving for a rapid recovery from environmental damage and if feasible, a quick return to normal facility operations. Those leading the recovery effort must be aware that rapid response without assessing the risks associated with the recovery effort can lead to increased damage and longer recovery times for the environment. Planning for the recovery phase during the prevention, preparedness and response process will improve recovery time and reduce impacts to the natural environment.

Factors, such as the extent of damage, availability and commitment of personnel, resources and finances all determine how long the recovery process will take. It is important to establish a pre-planned capability to recover and undertake swift damage assessments, because the longer it takes to recover, the higher the ultimate cost.

Four suggested steps to damage assessment in a recovery situation are as follows:

(1) determine the extent of the damage and appropriate communication to all relevant parties, including the public;

(2) develop a system to bring in the right resources, including people, at the right time;
(3) work with outside resources to support recovery;
(4) organize community resources necessary for people recovering from an emergency situation.

### 4.5. Rationale

The complexity of environmental emergency plans may vary depending upon the circumstances. Although the primary goal of preparing and implementing an environmental emergency plan is to prevent emergencies from occurring, planning is critical for preparedness and response activities in the event that an emergency does occur. Affected persons may prepare a plan in the form that makes the most sense for their organization, so long as the plan is aimed at reducing potential risks and addresses the following elements:

- The properties and characteristics of the substance.
- The maximum expected quantity of the substance at the place at any time during a calendar year.
- The commercial, manufacturing, processing or other activity in relation to which the plan is prepared.
- The characteristics of the place where the substance is located and of the surrounding area that may increase the risk of harm to the environment or of danger to human life or health.
- The potential consequences from an environmental emergency on the environment and on human life or health. Consequences are identified through the use of worst case and alternative scenarios. For more information, see the Risk Management Guide for Major Industrial Accidents (CRAIM), Version 2002.

If an environmental emergency plan is required under the section 200 Regulations, the following elements are compulsory. Although they are not mandatory under section 199, they must be considered:

- a description of the factors considered above;
- the identification of any environmental emergency that can reasonably be expected to occur at the place and that would likely cause harm to the environment or constitute a danger to human life or health and identification of the harm or danger;
- a description of the measures to be used to prevent, prepare for, respond to and recover from any environmental emergency identified above;
- a list of the individuals, identified by name or position, who are to carry into effect the plan in the event of an environmental emergency and a description of their roles and responsibilities;
- the identification of the training required for each of those individuals;
- a list of the emergency response equipment included as part of the environmental emergency plan and the equipment's location;
- the identification of measures to be taken to notify members of the public who may be adversely affected by an environmental emergency.

It is strongly encouraged to identify the facility's 5-year accident history, including all accidental releases that have resulted in deaths, injuries or significant property damage on-site or known off-site deaths, injuries, evacuations, sheltering in place, property or environmental damages. In addition, senior-level commitment to the environmental emergency planning measures identified is considered critical, both at the corporate level and at the facility concerned.

### 4.6. Participation of the public

It is strongly recommended that persons preparing an environmental emergency plan include community and interest groups as well as local and provincial emergency authorities in the development and preparation of the plan and also share the implemented plan with these persons. Communication of risk to surrounding communities is an essential component of both prevention and preparedness activities. Communication of information on what citizens should do in the event of an emergency is critical and the ability of citizens to react is an essential component of preparedness. Communication of this nature can help dispel undue fears over risks that may not be present and can also assure the community that risks that are present are under proper control. It is important to note, however, that there may be security issues regarding the information being communicated and some restrictions may apply.

### 4.7. Tests and exercises

Tests and exercises are simulations of a possible emergency. Testing of the environmental emergency plan shows if the facility can adequately deal with the scenario that is presented in the exercise. Initial testing should include informing those affected that a test is being planned. This will enable responders and participants to react in the proper manner through adequate pre-planning. Once the skills and knowledge have been demonstrated, the scenario can be tested with only the exercise design team knowledgeable in advance. Testing must reflect a credible type of event for the facility in question. When designing an exercise, the planners should ensure that it reinforces any previous training, is simple enough that available resources are adequate but difficult enough to be challenging, provides maximum lessons learned, includes post-exercise evaluation and corrective action and is cost effective.

The type of exercise chosen depends on its purpose, the availability of resources and the limitations of conducting exercises that apply to the location of operations. Exercises can be either administrative or operational. Administrative exercises are usually held in a conference room environment and can be tabletop or synthetic. Synthetic exercises are pre-programmed exercises in which all participants use computers. Operational exercises include those where communications are tested and major or full-blown exercises. A major exercise is similar in content to a tabletop exercise except that it is intended to provide a realistic simulation of an emergency response and all the required resources are actually deployed.

High-profile sites, such as refineries, petrochemical plants, etc. and sites with real potential for serious and irreversible harm to human health or the environment should have to develop and execute a full-blown emergency response exercise. Depending on the nature of the hazard and situation, sites with lower hazards or single substances could use generic plans and exercises developed by their associations, adapted and implemented locally.

The exercise design process is composed of five main steps:

(1) devising a multi-year program; a full-blown exercise may not be necessary every year, but should be conducted at least once as part of the multi-year cycle;
(2) planning the annual exercise;
(3) holding the exercise;
(4) evaluating the outcomes;
(5) reporting on the outcomes.

If more than one of the listed substances are identified in a facility's plan, it is not necessary to carry out exercises for each of them. There is a maximum flexibility for deciding how this can be documented in the environmental emergency plan and carried out. One approach might be to address all the flammables and the other hazardous substances as two separate groups in the plan and document the prevention, preparedness, response and recovery activities required for each group. For example, testing could focus on the flammables during the first year, while the other hazardous substances could be covered the following year. The principal objective is to ensure that all aspects of the plan are fully evaluated over the multi-year testing cycle.

The insights gained from this process are invaluable to the organization should a real emergency ever strike.

Responding to an actual incident is not usually a valid or appropriate test of the emergency plan. An actual incident may be considered a test of the environmental emergency plan only if certain conditions are met. For an actual incident to be recognized as a test, it must include the appropriate agencies, proper debriefing and evaluation, corrective actions and documentation as in a typical exercise. Solely responding to an actual incident is not necessarily a valid or appropriate test of the emergency plan, as follow-up to determine what happened and its broader implications for the plan as a whole is required for learning and improvement. It would be detrimental to apply an untested plan, as it may not be adequate to handle the emergency at hand. Testing or exercising enables critical aspects of the plan to be examined in a structural way, simulating conditions to reveal major mistakes and omissions so that they can be subsequently corrected without disastrous consequences.

A record of all results obtained during review or testing of the environmental emergency plan must be kept on-site for not less than 5 years.

## 5. Conclusion

A partnership approach initiated by the Major Industrial Accident Council of Canada, the Canadian Chemical Producer Association *Responsible Care*$^{md}$ and by the Conseil pour la réduction des accidents industriel majeur, is the foundation on which the new Canadian regulation on environmental regulation is constructed. The open dialogue with the community is an asset to develop better prevention, preparedness, response and recovery plans. It is also required for the development of a safety culture.

## Appendix A. List of hazardous substances with threshold quantities

| {Private} Column 1 | | | Column 2 | Column 3 |
|---|---|---|---|---|
| CAS registry number | Name of substance | UN number | Concentration (%) | Minimum quantity (tonnes) |
| Part 1—flammable substances | | | | |
| 60-29-7 | Ethyl ether (diethyl ether) | 1155 | 1 | 4.50 |
| 71-43-2 | Benzene | 1114 | 1 | 10.00 |
| 74-82-8 | Methane | 1971 and 1972 | 1 | 4.50 |
| 74-84-0 | Ethane | 1035 and 1961 | 1 | 4.50 |
| 74-85-1 | Ethylene | 1038 and 1962 | 1 | 4.50 |
| 74-86-2 | Acetylene | 1001 | 1 | 4.50 |
| 74-89-5 | Methylamine | 1061 | 1 | 4.50 |
| 74-98-6 | Propane | 1978 | 1 | 4.50 |
| 74-99-7 | Methylacetylene (propyne) | 1060 | 1 | 4.50 |
| 75-00-3 | Ethyl chloride | 1037 | 1 | 4.50 |
| 75-01-4 | Vinyl chloride | 1086 | 1 | 4.50 |
| 75-02-5 | Vinyl fluoride | 1860 | 1 | 4.50 |

Appendix A (*Continued*)

| {Private} Column 1 | | | Column 2 | Column 3 |
|---|---|---|---|---|
| CAS registry number | Name of substance | UN number | Concentration (%) | Minimum quantity (tonnes) |
| 75-04-7 | Ethylamine | 1036 and 2270 | 1 | 4.50 |
| 75-07-0 | Acetaldehyde | 1089 | 1 | 4.50 |
| 75-08-1 | Ethyl mercaptan | 2363 | 1 | 4.50 |
| 75-18-3 | Dimethyl sulphide | 1164 | 1 | 150 |
| 75-19-4 | Cyclopropane | 1027 | 1 | 4.50 |
| 75-28-5 | Isobutane | 1969 | 1 | 4.50 |
| 75-29-6 | 2-Chloropropane (isopropyl chloride) | 2356 | 1 | 4.50 |
| 75-31-0 | Isopropylamine | 1221 | 1 | 4.50 |
| 75-35-4 | Vinylidene chloride | 1303 | 1 | 4.50 |
| 75-37-6 | Difluoroethane (1,1-difluoroethane) | 1030 | | 4.50 |
| 75-38-7 | 1,1-Difluoroethylene (vinylidene fluoride) | 1959 | 1 | 4.50 |
| 75-50-3 | Trimethylamine | 1083 and 1297 | 1 | 4.50 |
| 75-64-9 | *tert*-Butylamine (2-amino-2-methylpropane) | 1125 | 1 | 150 |
| 75-76-3 | Tetramethylsilane | 2749 | 1 | 4.50 |
| 78-78-4 | Isopentane (2-methylbutane) | 1265 | 1 | 4.50 |
| 78-79-5 | Isoprene | 1218 | 1 | 4.50 |
| 79-38-9 | Trifluorochloroethylene (chlorotrifluoroethylene) | 1082 | 1 | 4.50 |
| 100-41-4 | Ethylbenzene | 1175 | 1 | 7000 |
| 106-97-8 | Butane | 1011 | 1 | 4.50 |
| 106-98-9 | 1-Butene (alpha-butylene) | 1012 | 1 | 4.50 |
| 106-99-0 | 1,3-Butadiene | 1010 | 1 | 4.50 |
| 107-00-6 | Ethylacetylene | 2452 | 1 | 4.50 |
| 107-01-7 | 2-Butene | 1055 | 1 | 4.50 |
| 107-25-5 | Vinyl methyl ether | 1087 | 1 | 4.50 |
| 107-31-3 | Methyl formate | 1243 | 1 | 4.50 |
| 108-88-3 | Toluene | 1294 | 1 | 2500 |
| 109-66-0 | *n*-Pentane (pentane) | 1265 | 1 | 4.50 |
| 109-67-1 | 1-Pentene | 1108 | 1 | 4.50 |
| 109-92-2 | Vinyl ethyl ether (ethyl vinyl ether) | 1302 | 1 | 4.50 |
| 109-95-5 | Ethyl nitrite | 1194 | 1 | 4.50 |
| 110-82-7 | Cyclohexane | 1145 | 1 | 550 |
| 115-07-1 | Propylene | 1077 | 1 | 4.50 |
| 115-10-6 | Dimethyl ether (methyl ether) | 1033 | 1 | 4.50 |
| 115-11-7 | Isobutylene (2-methylpropene) | 1055 | 1 | 4.50 |
| 116-14-3 | Tetrafluoroethylene | 1081 | 1 | 4.50 |
| 124-40-3 | Dimethylamine | 1032 and 1160 | 1 | 4.50 |
| 460-19-5 | Cyanogen | 1026 | 1 | 4.50 |
| 463-49-0 | Propadiene | 2200 | 1 | 4.50 |
| 463-58-1 | Carbonyl sulphide (carbon oxysulfide) | 2204 | 1 | 4.50 |
| 463-82-1 | 2,2-Dimethylpropane | 2044 | 1 | 4.50 |
| 504-60-9 | 1,3-Pentadiene | NA | 1 | 4.50 |
| 557-98-2 | 2-Chloropropene (2-chloropropylene) | 2456 | 1 | 4.50 |
| 563-45-1 | 3-Methyl-1-butene | 2561 | 1 | 4.50 |
| 563-46-2 | 2-Methyl-1-butene | 2459 | 1 | 4.50 |
| 590-18-1 | *cis*-2-Butene (2-butene-*cis*) | 1055 | 1 | 4.50 |
| 590-21-6 | 1-Chloropropene (1-chloropropylene) | NA | 1 | 4.50 |
| 598-73-2 | Bromotrifluoroethylene | 2419 | 1 | 4.50 |
| 624-64-6 | *trans*-2-Butene (2-butene-*trans*) | 1055 | 1 | 4.50 |
| 627-20-3 | *cis*-2-Pentene (beta-*cis*-amylene) | NA | 1 | 4.50 |
| 646-04-8 | *trans*-2-Pentene (*trans*-beta-amylene) | NA | 1 | 4.50 |
| 689-97-4 | 1-Buten-3-yne (vinyl acetylene) | NA | 1 | 4.50 |
| 1330-20-7 | Xylenes | 1307 | 1 | 8000 |
| 1333-74-0 | Hydrogen | 1049 | 1 | 4.50 |
| 4109-96-0 | Dichlorosilane | 2189 | 1 | 4.50 |
| 7722-84-1 | Hydrogen peroxide | 2015 | 52 | 3.40 |
| 7775-09-9 | Sodium chlorate | 1495 | 1 | 10.00 |
| 7790-98-9 | Ammonium perchlorate | 1442 | 1 | 3.40 |
| 7791-21-1 | Chlorine monoxide (dichlorine oxide) | NA | 1 | 4.50 |
| 7803-62-5 | Silane | 2203 | 1 | 4.50 |
| 8006-14-2 | Liquefied natural gas | 1972 | 1 | 4.50 |
| 8030-30-6 | Naphtha | 1268 | 1 | 50.00 |

Appendix A (*Continued*)

| {Private} Column 1 | | | Column 2 | Column 3 |
|---|---|---|---|---|
| CAS registry number | Name of substance | UN number | Concentration (%) | Minimum quantity (tonnes) |
| 10025-78-2 | Trichlorosilane | 1295 | 1 | 4.50 |
| 25167-67-3 | Butylene (butene) | 1012 | 1 | 4.50 |
| 86290-81-5 | Gasoline (motor fuel) | 1203 | 1 | 150 |
| Part 2—toxic substances | | | | |
| 50-00-0 | Formaldehyde, solution | 1198 and 2209 | 10 | 6.80 |
| 57-14-7 | 1,1-Dimethylhydrazine | 1163 | 10 | 6.80 |
| 60-34-4 | Methylhydrazine (monomethyl hydrazine) | 1244 | 10 | 6.80 |
| 67-66-3 | Chloroform (trichloromethane) | 1888 | 10 | 9.10 |
| 74-83-9 | Methyl bromide | 1062 | 10 | 2.27 |
| 74-87-3 | Methyl chloride | 1063 | 10 | 4.50 |
| 74-88-4 | Methyl iodide | 2644 | 10 | 4.50 |
| 74-90-8 | Hydrogen cyanide (hydrocyanic acid) | 1051, 1613 and 1614 | 10 | 1.13 |
| 74-93-1 | Methyl mercaptan | 1064 | 10 | 4.50 |
| 75-15-0 | Carbon disulphide | 1131 | 10 | 9.10 |
| 75-21-8 | Ethylene oxide | 1040 | 10 | 4.50 |
| 75-44-5 | Phosgene | 1076 | 1 | 0.22 |
| 75-55-8 | Propyleneimine | 1921 | 10 | 4.50 |
| 75-56-9 | Propylene oxide | 1280 | 10 | 4.50 |
| 75-74-1 | Tetramethyl lead | NA | 10 | 4.50 |
| 75-77-4 | Trimethylchlorosilane (chlorotrimethylsilane) | 1298 | 10 | 4.50 |
| 75-78-5 | Dimethyldichlorosilane (dichlorodimethylsilane) | 1162 | 10 | 2.27 |
| 75-79-6 | Methyltrichlorosilane | 1250 | 10 | 2.27 |
| 76-06-2 | Chloropicrin (trichloronitromethane) | 1580 | 10 | 2.27 |
| 78-00-2 | Tetraethyl lead | 1649 | 10 | 2.27 |
| 78-82-0 | Isobutyronitrile | 2284 | 10 | 9.10 |
| 79-21-0 | Peroxyacetic acid (peracetic acid) | 3107 | 10 | 4.50 |
| 79-22-1 | Methyl chloroformate | 1238 | 10 | 2.27 |
| 91-08-7 | Toluene-2,6-diisocyanate | 2078 | 10 | 4.50 |
| 106-89-8 | Epichlorohydrin | 2023 | 10 | 9.10 |
| 107-02-8 | Acrolein | 1092 | 10 | 2.27 |
| 107-05-1 | Allyl chloride | 1100 | 10 | 9.10 |
| 107-06-2 | 1,2-Dichloroethane (ethylene dichloride) | 1184 | 10 | 6.80 |
| 107-07-3 | Ethylene chlorohydrin (2-chloroethanol) | 1135 | 10 | 4.50 |
| 107-11-9 | Allylamine | 2334 | 10 | 4.50 |
| 107-12-0 | Propionitrile | 2404 | 10 | 4.50 |
| 107-13-1 | Acrylonitrile | 1093 | 10 | 9.10 |
| 107-15-3 | Ethylenediamine | 1604 | 10 | 9.10 |
| 107-18-6 | Allyl alcohol | 1098 | 10 | 6.80 |
| 107-30-2 | Chloromethyl methyl ether (methyl chloromethyl ether) | 1239 | 10 | 2.27 |
| 108-05-4 | Vinyl acetate | 1301 | 10 | 6.80 |
| 108-23-6 | Isopropyl chloroformate | 2407 | 10 | 6.80 |
| 108-91-8 | Cyclohexylamine | 2357 | 10 | 6.80 |
| 108-95-2 | Phenol | 1671, 2312 and 2821 | 10 | 9.10 |
| 109-61-5 | *n*-Propyl chloroformate (propyl chloroformate) | 2740 | 10 | 6.80 |
| 110-00-9 | Furan | 2389 | 10 | 2.27 |
| 110-89-4 | Piperidine | 2401 | 10 | 6.80 |
| 123-73-9 | *trans*-Crotonaldehyde | 1143 | 10 | 9.10 |
| 126-98-7 | Methylacrylonitrile | 3079 | 10 | 4.50 |
| 151-56-4 | Ethyleneimine | 1185 | 10 | 4.50 |
| 302-01-2 | Hydrazine | 2029 | 10 | 6.80 |
| 353-42-4 | Boron trifluoride dimethyl etherate | 2965 | 10 | 6.80 |
| 463-51-4 | Ketene | NA | 1 | 0.22 |
| 506-68-3 | Cyanogen bromide | 1889 | 10 | 4.50 |
| 506-77-4 | Cyanogen chloride | 1589 | 10 | 4.50 |
| 509-14-8 | Tetranitromethane | 1510 | 10 | 4.50 |
| 542-88-1 | bis(Chloromethyl) ether [dichlorodimethyl ether] | 2249 | 1 | 0.45 |
| 556-64-9 | Methyl thiocyanate | NA | 10 | 9.10 |
| 584-84-9 | Toluene-2,4-diisocyanate | 2078 | 10 | 4.50 |
| 594-42-3 | Perchloromethyl mercaptan | 1670 | 10 | 4.50 |
| 624-83-9 | Methyl isocyanate | 2480 | 10 | 4.50 |
| 630-08-0 | Carbon monoxide | 1016 | 10 | 6.80 |

Appendix A (*Continued*)

| {Private} Column 1 | | | Column 2 | Column 3 |
|---|---|---|---|---|
| CAS registry number | Name of substance | UN number | Concentration (%) | Minimum quantity (tonnes) |
| 814-68-6 | Acryloyl chloride (acrylyl chloride) | NA | 10 | 2.27 |
| 4170-30-3 | Crotonaldehyde | 1143 | 10 | 9.10 |
| 7439-97-6 | Mercury | 2809 | NA | 1.00 |
| 7446-09-5 | Sulphur dioxide | 1079 | 10 | 2.27 |
| 7446-11-9 | Sulphur trioxide | 1829 | 10 | 4.50 |
| 7550-45-0 | Titanium tetrachloride | 1838 | 10 | 1.13 |
| 7616-94-6 | Perchloryl fluoride (trioxychlorofluoride) | 3083 | 10 | 6.80 |
| 7637-07-2 | Boron trifluoride | 1008 | 10 | 2.27 |
| 7647-01-0 | Hydrochloric acid | 1789 | 30 | 6.80 |
| 7647-01-0 | Hydrogen chloride, anhydrous | 2186 and 1050 | 10 | 2.27 |
| 7664-39-3 | Hydrofluoric acid | 1790 | 50 | 0.45 |
| 7664-39-3 | Hydrogen fluoride, anhydrous | 1052 | 1 | 0.45 |
| 7664-41-7 | Ammonia, anhydrous | 1005 | 10 | 4.50 |
| 7664-41-7 | Ammonia solution | 2073 and 2672 | 20 | 9.10 |
| 7697-37-2 | Nitric acid | 2031 and 2032 | 80 | 6.80 |
| 7719-09-7 | Thionyl chloride | 1836 | 10 | 6.80 |
| 7719-12-2 | Phosphorus trichloride | 1809 | 10 | 6.80 |
| 7723-14-0 | Phosphorus, white | 2447 | NA | 1.00 |
| 7726-95-6 | Bromine | 1744 | 10 | 4.50 |
| 7782-41-4 | Fluorine | 1045 | 1 | 0.45 |
| 7782-50-5 | Chlorine | 1017 | 10 | 1.13 |
| 7783-06-4 | Hydrogen sulphide | 1053 | 10 | 4.50 |
| 7783-07-5 | Hydrogen selenide | 2202 | 1 | 0.22 |
| 7783-60-0 | Sulphur tetrafluoride | 2418 | 10 | 1.13 |
| 7784-34-1 | Arsenic trichloride (arsenous trichloride) | 1560 | 10 | 6.80 |
| 7784-42-1 | Arsine | 2188 | 1 | 0.45 |
| 7790-94-5 | Chlorosulphonic acid | 1754 | 10 | 2.27 |
| 7803-51-2 | Phosphine | 2199 | 10 | 2.27 |
| 7803-52-3 | Stibine | 2676 | 10 | 2.27 |
| 8014-95-7 | Sulphuric acid, fuming (oleum) | 1831 | NA | 4.50 |
| 10025-87-3 | Phosphorus oxychloride | 1810 | 10 | 2.27 |
| 10035-10-6 | Hydrogen bromide (hydrobromic acid) | 1048 and 1788 | 10 | 1.13 |
| 10049-04-4 | Chlorine dioxide | NA | 1 | 0.45 |
| 10102-43-9 | Nitric oxide (nitrogen monoxide) | 1660 | 10 | 4.50 |
| 10102-44-0 | Nitrogen dioxide | 1067 | 10 | 1.13 |
| 10294-34-5 | Boron trichloride | 1741 | 10 | 2.27 |
| 13463-39-3 | Nickel carbonyl | 1259 | 1 | 0.45 |
| 13463-40-6 | Iron pentacarbonyl | 1994 | 10 | 1.13 |
| 19287-45-7 | Diborane | 1911 | 10 | 1.13 |
| 20816-12-0 | Osmium tetroxide | 2471 | 1 | 0.22 |
| 26471-62-5 | Toluene diisocyanate | 2078 | 10 | 4.50 |

*Note:* The percentage concentration in column 2 is the percentage concentration based on the proportion of the weight of the substance to the weight of the mixture.

## References

[1] Canadian Chemical Producers Association, Working with communities: examples of responsible care in action, http://www.ccpa.ca/ResponsibleCare/Success.aspx.

[2] Canadian Chemical Producers Association, Community awareness and emergency response, http://www.itcilo.it/english/actrav/telearn/global/ilo/code/responsi.htm.

[3] Conseil pour la reduction des accidents industriels majeurs (CRAIM), Risk Management Guide for Major Industrial Accidents, Montreal, QC, Canada, July 2001.

[4] Proposed Environmental Emergency Regulation, Canada Gazette, Part 1, 8 August 2002, pp. 2437–2451.