Guidance Manual for the Risk Evaluation Framework for Sections 199 and 200 of CEPA 1999. Decisions on Environmental Emergency Plans

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Glossary

AEGL-2	Acute Exposure Guideline Levels – 2. The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
BAF	Bioaccumulation Factor. In aquatic organisms this is the ratio of the concentration of a substance in an organism, and the concentrations in the water and diet that the organism is exposed to.
BCF	Bioconcentration Factor. This is the ration of the concentration of a substance in an organism and the concentration of the medium surrounding the organism (water, air, soil, etc.).
Boiling point	Boiling point is the temperature at which the vapour pressure of a liquid exceeds atmospheric pressure. Since atmospheric pressure can no longer keep the substance in the liquid state, bubbles begin to form and the material converts into a vapour. Boiling point provides us a relative index of a liquid's volatility
CRAIM	Conseil pour la reduction des accidents industriels majeurs: the Montréal section of the now defunct Major Industrial Accidents Council of Canada (MIACC).
DSL	Domestic Substances List
E2 Plans	Environmental Emergency (E2) Plans address the prevention of, preparedness for, responses to and recovery from environmental emergencies in order to repair, reduce or mitigate the negative effects of an incident.
EC50	Effective Concentration 50. The concentration of a substance that has a specified non-lethal effect on half of the test organisms within a specified period of time. Effects measured are often number of young produced, time to reproduction, etc.
EER	Environmental Emergency Regulations under Section 200 of CEPA 1999 (proposed). Schedule I of the proposed regulation lists 174 chemicals that would require E2 Plans.
ERPG-2	Emergency Response Planning Guideline – 2. The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
emergencies pathway	Ways that a chemical could enter the environment so as to meet the definition of environmental emergency.

Environmental Emergency	Section 193 of CEPA "Environmental Matters Related to Emergencies" definition: a) an uncontrolled, unplanned or accidental release, or release in contravention of regulations made under this Part, of a substance into the environment; or b) the reasonable likelihood of such a release into the environment.
Flash point	Flash point is defined as the lowest temperature at which a flammable liquid gives off sufficient vapour to form an ignitable mixture with air near its surface or within a vessel.
Half-life	The time needed to reduce the quantity of a chemical by transformation to half its initial quantity in the environment. Denoted by T½.
Hazard Score	Hazard Scores are calculated by the REF to determine overall hazards for human, environmental and physical parameters.
IARC	International Agency for Research on Cancer
IC50	Inhibitory Concentration 50. The concentration of a substance estimated to inhibit the biological endpoint of interest (e.g. cell growth) by 50%.
Kow	The octanol-water partition coefficient K_{ow}, usually presented as a logarithm (log K_{ow}), is considered a surrogate for BCF in the simplest model of bioaccumulation. The log K_{ow} is a measure of how polar the substance is by determining whether the substance partitions primarily to water or to octanol. Substances that partition primarily to octanol are likely to bioaccumulate in the fat of organisms.
LC50	Lethal Concentration 50. The estimated concentration of a substance required to cause death in 50% of the test organisms in a specified time period.
LD50	Median Lethal Dose. A statistically derived single dose of a substance that can be expected to cause death in 50% of the animals. This value is expressed in terms of the weight of the test substance per unit weight of the test animal (e.g. mg/kg bw).
NFPA	U.S. National Fire Protection Association
NPRI	National Pollutant Release Inventory
PBT	Persistence, Bioaccumulation and Toxicity
REF	The Risk Evaluation Framework is a scoring system done in Microsoft Excel that incorporates the CRAIM criteria for human health and safety with environmental criteria.
S199	Section 199 of CEPA 1999 requires an assessment of all substances on the Toxic Substances List for E2 Plans.

S200	Section 200 of CEPA 1999 allows the Minister of the Environment to require E2 Plans for chemicals that meet the CEPA toxicity definition as a result of an environmental emergency.
STEL	Short Term Exposure Level. The concentration to which workers can be exposed continuously for a short period of time (usually 10 or 15 minutes) without suffering from: irritation; chronic or irreversible tissue damage; or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.
TSMP	Toxic Substances Management Policy
trigger values	Values in the REF that by themselves trigger the requirement for an E2 Plan.

1 Introduction

Sections 199 and 200 of *Canadian Environmental Protection Act, 1999* (Government of Canada, 1999) enable Environment Canada to require persons, who own or manage specified toxic and hazardous substances, to develop and implement environmental emergency plans if they are using or handling CEPA "toxic" substances (S199) or if they are using or handling hazardous substances that could be listed in the Environmental Emergencies Regulations (EER) under S200. This paper will focus on the methodology for determining how a chemical is assessed for requiring an environmental emergency (E2) plan. E2 plans address the prevention of, preparedness for, responses to and recovery from environmental emergencies in order to repair, reduce or mitigate the negative effects of an incident.

There was a need to have a methodology for determining when either a CEPA "toxic" compound or a potentially hazardous chemical required an environmental emergency plan. For S199, once the substances are declared CEPA "toxic" then each chemical is assessed to determine whether it requires a plan or not. For S200, any chemical can be added under the proposed Environmental Emergencies Regulations (Environment Canada, 2002a), CEPA "toxic" or not, so long as it can be ascertained that the substance is toxic in regards to the following criteria, 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.

The current list of 174 chemicals on Schedule I of the EER was derived from a list of chemicals proposed by the Conseil pour la reduction des accidents industriels majeurs (CRAIM, 2002), which was the Montréal section of the now defunct Major Industrial Accidents Council of Canada (MIACC). This list is a compilation of the U.S. Environmental Protection Agency Risk Management Program (US EPA, 2002a) list of chemicals and the MIACC List 2 chemicals. The CRAIM list was designed to take into account the List of Hazardous Substances from the EPA RMP while also retaining the most hazardous substances from the MIACC List 2. The rationale for the CRAIM List focused almost entirely on human health and safety criteria (CRAIM 2002; J.P. Lacoursière Inc., 2002). In keeping with Environment Canada's mandate to protect the environment, methodology was developed to incorporate environmental criteria to evaluate CEPA "toxic" substances from S199, those already on Schedule I of S200 and other new compounds to be added to the Environmental Emergency Regulations.

This is the guidance manual for evaluation of organic and some inorganic substances. It does not apply to metals, complex effluents or mixtures, pesticides, or biological materials. Suitable criteria will be developed or determined in the near future. The REF also does not apply to explosives or radioactive materials as emergency response aspects are adequately covered under other federal government legislation.

2 The Process

The first step in the process was to gather information on the chemicals listed on the Toxic Substances List (Environment Canada, 2002b) based on a guidance document prepared for contractors

(Environment Canada, 2002c). The risk evaluation, described in this document, is then conducted in order to identify which of the chemicals required an environmental emergency plan. Once it is determined that a plan is required for specific substances, the Minister of the Environment then has the authority to request that one be prepared and implemented by all those using or storing these particular substances at or above specified thresholds. Therefore the risk evaluation framework described below is an important tool in evaluating the hazards posed by both toxic and other hazardous substances found in Canada.

2.1 Pre-assessment Filter

The first step in assessing a chemical's requirement for an E2 plan is to determine whether an environmental emergency scenario could potentially exist. The following pre-screening criteria must be satisfied before a chemical is evaluated further:

1. Is the chemical in commerce in Canada?
2. Are emergency plans covered by another act of Parliament?
3. Are there realistic emergency pathways?

2.1.1 Is the chemical in commerce in Canada?

The first question can typically be answered by accessing the Domestic Substances List (DSL), which will tell you whether it is potentially in Canadian commerce. However, because information in the DSL is somewhat dated, other sources should also be consulted. Further investigation through chemical supply catalogues, the National Pollutant Release Inventory, Statistics Canada, Customs Canada, Natural Resources Canada and other sources may be required to determine if there is a significant usage in Canada. Other sources may also provide information on facilities where the substance is manufactured, used, and other possibly relevant information. There is no consensus for a lower limit of volume or weight that has been determined. Small amounts of a substance in Canadian commerce will be exempted from hazard evaluation on a case-by-case basis. Substances slated for existing or pending ban, phase-out, or life cycle management will be identified. Below is a suggested list of references to use when searching for the existence of a particular chemical in Canadian commerce.

- Domestic Substances List http://www.ec.gc.ca/substances/nsb/eng/sub_e.htm
- Canadian Chemical Directory (book available from Camford Information Services Inc. http://www.camfordinfo.com/CBG.html)
- CPI Product Profiles (available from Camford Information Services Inc. http://www.camfordinfo.com)
- National Pollutant Release Inventory http://www.npri-inrp.com/queryform.cfm
- Natural Resources Canada
  - Minerals and Metals Commodity Review http://www.nrcan.gc.ca/mms/cmy/CMY_E3.html
  - Canadian Minerals Yearbook http://www.nrcan.gc.ca/mms/cmy/index.htm
  - Fact Sheets and Information Bulletins http://www.nrcan.gc.ca/mms/prod-serv/fs_e.htm
- Environment Canada's New Substances Program http://www.ec.gc.ca/substances/nsb/eng/index_e.htm
- Canadian Chemical Producer's Association: http://www.ccpa.ca/

2.1.2 Are emergency plans covered by another act of Parliament?

It has been determined that for some groups of substances other federal Acts adequately cover the emergencies aspects so that assessment under Sections 199 and 200 of CEPA 1999 may not apply. Substances requiring environmental emergency plans captured under section 199 and 200 all relate to chemicals that are stored at fixed facilities. Legislation has been shown that other emergency plans are in existence for the following groups of chemicals:

- explosives; covered by the Explosives Act
- radionuclides; covered by the Canadian Nuclear Safety Commission
- substances in transit via road and rail; covered by the Transportation of Dangerous Goods Act
- substances being shipped; covered by the Canada Shipping Act
- substances moving through pipelines; covered by the Onshore Pipeline Regulations
- substances moving through federally regulated Ports operated by Canada Port Authorities.

Applicable federal legislation on a particular substance can be searched at the following sites:

- Justice Canada has federal legislation on-line at: http://lois.justice.gc.ca/.
- Canada Centre for Occupational Health and Safety has a subscription database (enviroOSH) of relevant Canadian federal and provincial legislation on-line at: http://www.ccohs.ca/legislation/.
- Environment Canada CEPA Environmental Registry: http://www.ec.gc.ca/CEPARegistry/

2.1.3 Are there realistic emergency pathways?

CEPA 1999 defines an environmental emergency in Part 8, "Environmental Matters Related to Emergencies" in section 193 as:
a) an uncontrolled, unplanned or accidental release, or release in contravention of regulations made under this Part, of a substance into the environment; or
b) the reasonable likelihood of such a release into the environment.

It is not enough that a chemical is used in Canada in significant quantities for it to be assessed for E2 plans, it must also be used in a manner that could pose a threat to humans or the environment (e.g. storage facilities). Some substances on the List of Toxic Substances are components of municipal wastewater that are released by industries for treatment (e.g. textile mill effluents); some are unintended products of combustion or chemical processes (e.g. dioxins); and some are in a form that are released over a long period of time and cause chronic environmental problems (e.g. creosote contaminated sites). For those substances, there are no realistic emergency pathways and hence they will not be evaluated for an E2 plan.

2.2 Using the Risk Evaluation Framework (REF)

Once the pre-screening criteria have been satisfied, then the substance is assessed as to whether it requires an E2 plan. The first step is to select appropriate data from the data collection document for the substance. Data selected were peer reviewed such that there would be as little ambiguity as possible over the data to use in the REF. In most cases a single value will be presented for a parameter. In other cases, a parameter will be best represented by a range of values and consequently, the geometric mean of the data will be calculated and used. When the latter process occurs, it will be noted in the summary report.

There is no specific order to enter data for much of the REF, except for in the screening assessment subsection, where it is determined whether or not an assessment should be done, as well as in the human health hazard subsection. The evaluator should enter a value for vapour pressure prior to entering a value for human inhalation toxicity. This is to ensure that the chemical in question is sufficiently volatile to represent a hazard to humans and the environment. A vapour pressure greater than or equal to 1.333 kPa (10 mm Hg) is considered a possible human inhalation health threat based on the U.S. EPA criteria for their Clean Air Act. Other than that, data can be entered into any subsection, and edited if necessary. The spreadsheet will simply recalculate the values and update the conclusions.

The REF is a scoring system done in Microsoft Excel that incorporates the CRAIM criteria for human health and safety with environmental criteria. A substance is evaluated in three subsections: environmental hazard, human hazard and physical hazard. Appropriate data from the data collection document are scored according to the criteria tables found in this document. The resulting scores are entered into the REF. An E2 plan may be deemed a requirement based upon the scores of either the environmental health or human health or physical hazard subsections or any combination thereof. A decision for an E2 plan can also be made upon meeting or exceeding any of the single trigger values for most of the criteria used.

All data that were used in the REF spreadsheet are to be included into a chemical assessment report, including the references. When the assessment is completed the summary worksheet will display all of the conclusions that were derived from the REF.

2.2.1 The Criteria Tables

The REF incorporates the criteria used by the U.S. EPA to develop their Risk Management Program (RMP) list, as well as the criteria set used by CRAIM to select chemicals for potential disastrous human health hazards (CRAIM 2002; J.P. Lacoursière Inc., 2002). The environmental criteria contained in the tables were selected on the basis of international usage if at all possible. However, when divergent sets of criteria were found for that same parameter, those most often used in North America, especially those by the U.S. EPA were chosen to improve North American harmonization.

There are two ways in the REF that a chemical can be evaluated to require an E2 plan. The first method is to determine the hazard score for each of human, environmental and physical hazards. A Hazard Score is a ratio of the calculated hazard over the theoretical maximum hazard for one of the three areas (see Appendix X for an example, or the Excel Spreadsheet). The second method uses selected criteria with "trigger values" that when exceeded result in an automatic requirement for an E2 plan. These criteria are listed in Table 1. Regardless of whether a single trigger criterion has been exceeded, resulting in the recommendation of an E2 plan, all other criteria are also given a score. When a Hazard Score is calculated to be between 0.45 and 0.55 and there are no E2 plan triggers, then more or better data is required for further evaluation. Expert opinion on the usage of the particular substance may be appropriate for further consideration.

If there is a lack of data for a parameter, then the score box for that parameter is left blank and no theoretical score is incorporated into the Hazard Score. The lack of data can be critical if a small data set is used, as each number then has much greater weighting in the REF, and each can radically affect the outcome of the assessment.

Table 1. Trigger criteria for requirement of an E2 plan

Subsection	Criterion	Trigger Value
Environmental Health	Persistence	air: ≥ 1 day water/soil: ≥ 60 days sediments: ≥ 60 days
	Bioaccumulation	BCF/BAF: ≥ 1000 or log K_{ow}: ≥ 4
	Acute Aquatic Toxicity	> 0.1 to ≤ 1mg/L toxicity from either: 96-h LC_{50} for fish or, 48-h EC_{50} for invertebrates or, 72- or 96-h IC_{50} for algae/ plants
Human Health	Inhalation Toxicity	AEGL-2/ERPG-2/STEL: ≤ 50 ppm
	Dermal Toxicity	Rat/rabbit LD_{50}: ≤ 200 mg/kg
	Ingestion Toxicity	Rat LD_{50}: ≤ 50 mg/kg
	Carcinogenicity	Probable or likely human carcinogen.
	Corrosion/Skin Irritation	Corrosion of skin on contact.
Physical Safety	Flammability	NFPA Class 1A flammable liquids or an NFPA value of 4.
	Instability	Materials which in themselves are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. This degree should include materials which are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

2.2.2 Summary Report

A Summary Report is produced once the assessment is complete. It will provide the following: a conclusion regarding the requirement for an E2 plan, a summary of the criteria or subsections which triggered the E2 requirement, a detailed explanation of the rationale used to reach the conclusion including expert judgment, issues regarding uncertainty in data evaluation, data summary sheets, references and other pertinent information.

For the purpose of determining whether E2 Plans are required for chemicals in Canada the following information is included in the rating system:

2.2.2.1 Environmental Hazards

- Persistence (half-lives)
    - Air
    - Water
    - Soil
    - Sediments

- Bioaccumulation factor/bioconcentration factor/log K_{ow} (mentioned in order of preference)

- Toxic Endpoints
    - Acute aquatic toxicity (Freshwater or marine data depending upon which is more toxic).

2.2.2.2 Human Health Hazards

- Inhalation Toxicity: (chemical must have a vapour pressure of at least 1.333 kPa, if it is less then the chemical is not considered volatile enough to pose a threat to humans via inhalation)

-Non-lethal inhalation effects in humans shown in order of priority:

- Acute Exposure Guideline Levels-2 (AEGL-2) for 1-hr
- Emergency Response Planning Guidelines-2 (ERPG 2)
- Short-term exposure limit (STEL)

-Ingestion toxicity (rat LD_{50} data)

-Dermal toxicity (draize testing on rats or rabbits)

-Carcinogenicity (as rated by U.S. EPA or IARC)

-Corrosion/Skin Irritation

2.2.2.3 Physical Hazards

Flammability Hazard: (this single category incorporates flash point, boiling point and other parameters)

Instability (a measure of how readily the substance will undergo sudden chemical reactions)

Hazardous Decomposition Products (from fire, water, chemical reactions, etc.)

2.3 Schematic Diagrams of the REF Process

FIGURE 1. PRE-SCREENING ASSESSMENT

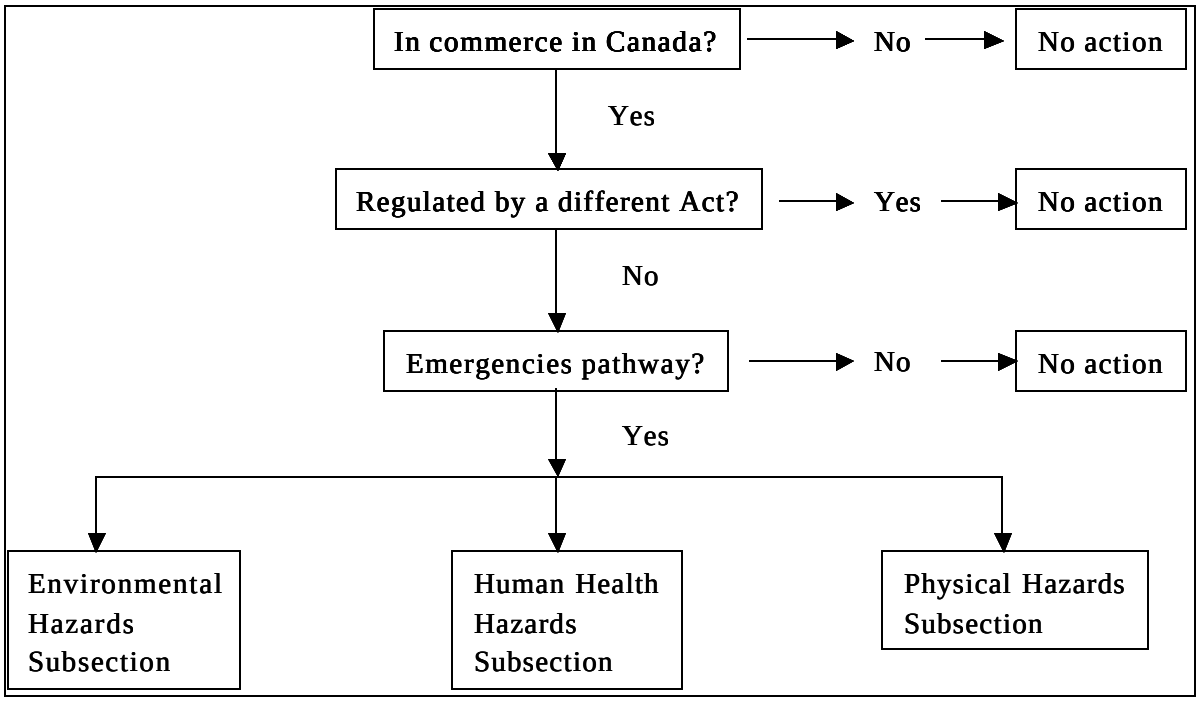


FIGURE 2. ENVIRONMENTAL HAZARDS SUBSECTION

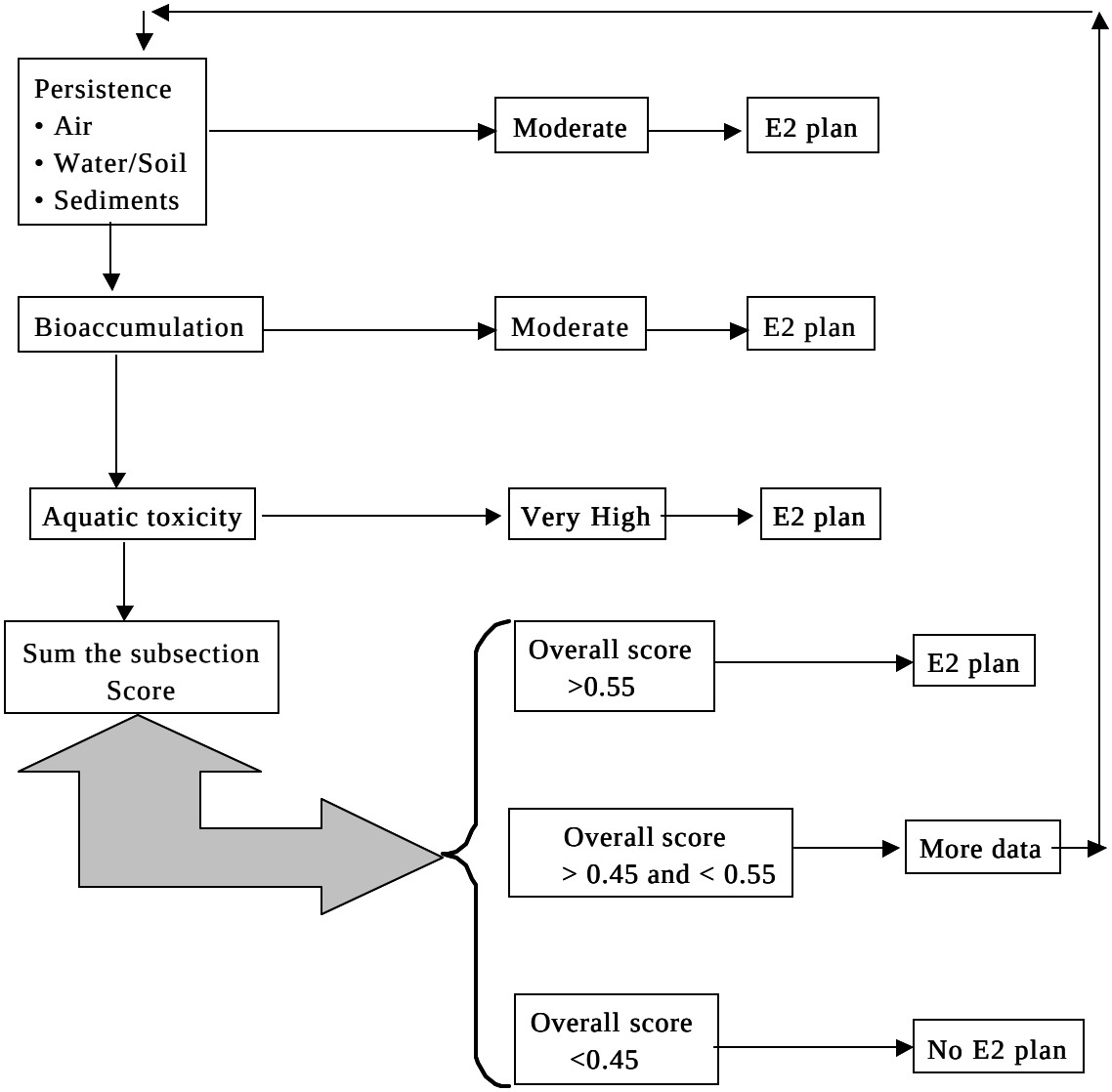


FIGURE 3. HUMAN HEALTH HAZARDS SUBSECTION

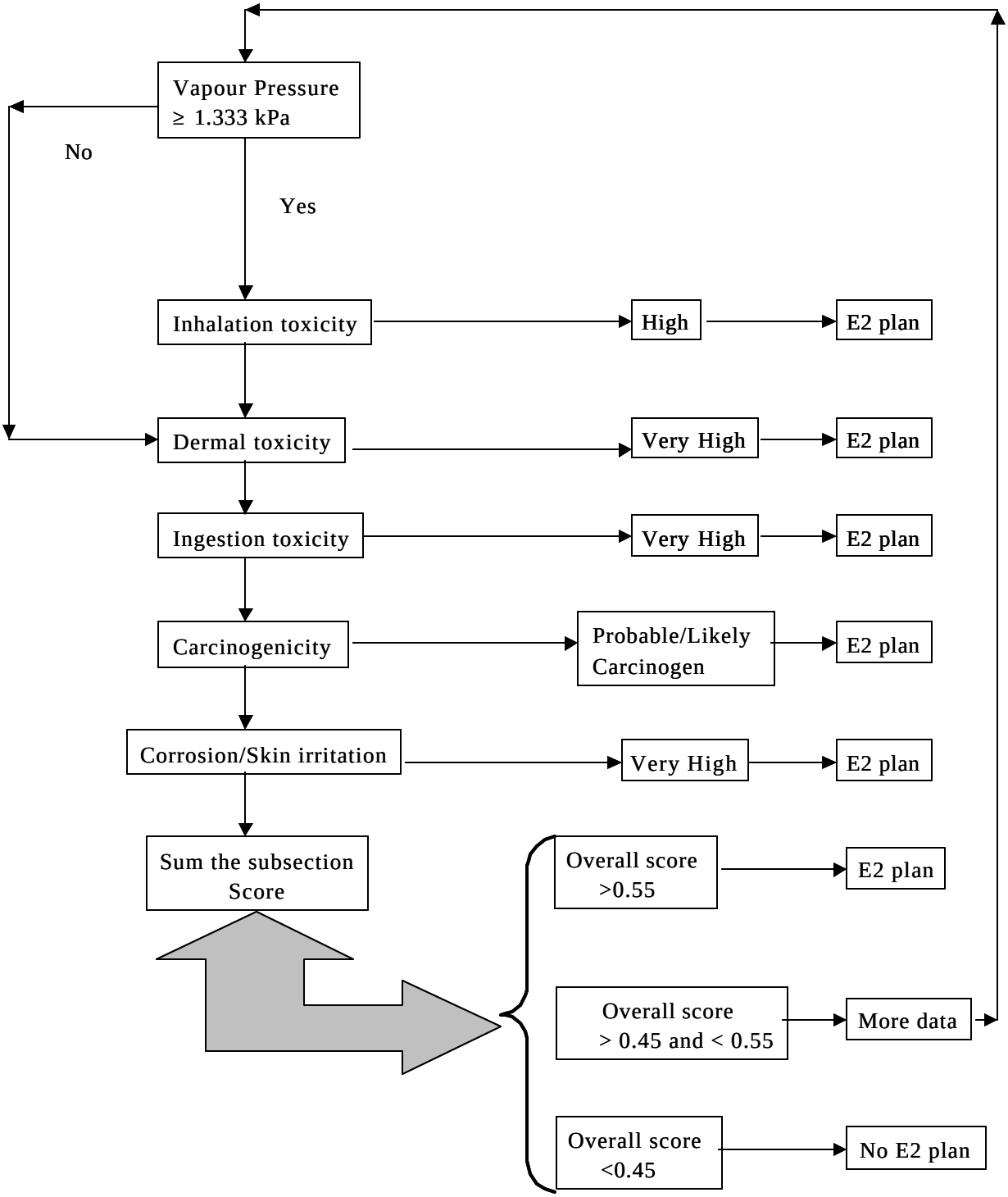
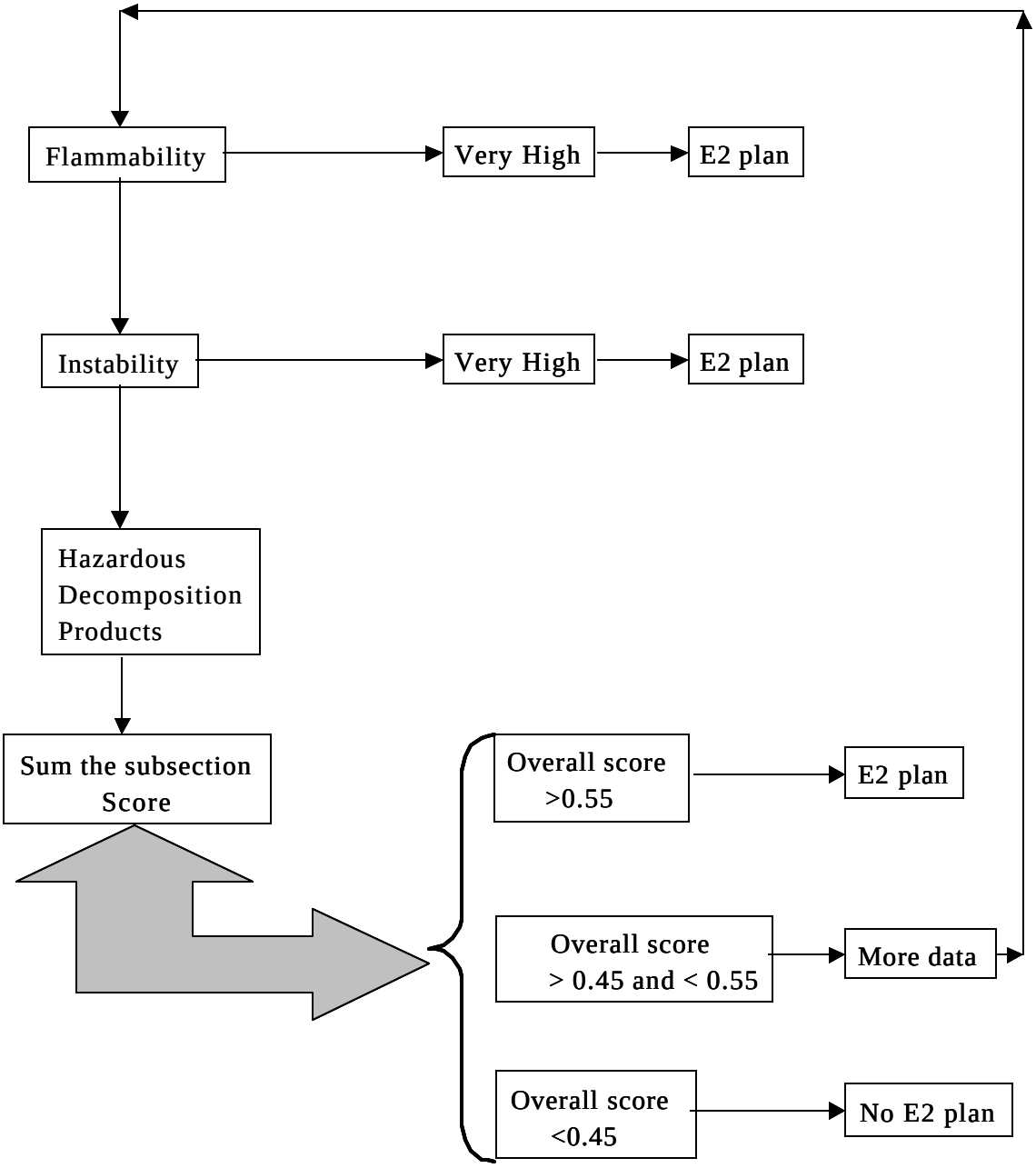


FIGURE 4. PHYSICAL SAFETY SUBSECTION



2.4 Detailed Descriptions of the Criteria

2.4.1 Environmental Hazard Ratings

Around the world, the cornerstones of most chemical hazard evaluations are persistence, bioaccumulation and toxicity (PBT) criteria. In Canada, the Toxic Substances Management Policy (TSMP) of CEPA uses PBT criteria for determining when an organic chemical is to be considered for "virtual elimination" in Canada. The virtual elimination of a toxic substance released into the environment, as a result of human activity, requires the ultimate reduction of its releases to the lowest concentration that can be accurately measured using routine sampling and analytical methods (Environment Canada, 1995). TSMP virtual elimination criteria are shown in Table 2. They are applicable only to organic chemicals not to metals or inorganic chemicals. Environmental behaviours of both metals and inorganic chemicals differ greatly from that of organic chemicals, consequently modified and/or different criteria are required for them.

Table 2. TSMP Criteria for the Selection of Substances for Virtual Elimination

Persistence (half-life)[1]	**Bioaccumulation**[3]	**Toxicity**[4]	**Predominantly anthropogenic**[5]
Air ≥ 2 days [2] Water ≥ 182 days Soil ≥ 182 days Sediment ≥ 365 days	BAF ≥ 5,000 or BCF ≥ 5,000 or log Kow ≥ 5.0	CEPA-toxic or CEPA-toxic equivalent	Concentration in environment largely resulting from human activity

[1] A substance is considered persistent when the criterion is met in any one medium.

[2] A substance may be considered as persistent in air if it is shown to be subject to atmospheric transport to remote regions such as the Arctic.

[3] Bioaccumulation Factors (BAF) are preferred over Bioconcentration Factors (BCF); in the absence of BAF or BCF data, the octanol-water partition coefficient (log Kow) may be used.

[4] A substance is considered toxic if it meets or is equivalent to the definition of "toxic" found in Section 64 of the *Canadian Environmental Protection Act 1999* (Government of Canada, 1999).

[5] A substance is predominantly anthropogenic if, based on expert judgement, its concentration in any environmental medium is largely due to human activity rather than to natural sources or releases. Naturally occurring inorganic substances, elements and radionuclides are not candidates for track 1 (virtual elimination). However, when warranted, a natural substance that is used or released as the result of human activity may be targeted for reduction to naturally occurring levels under track 2 (life-cycle management).

2.4.1.1 Persistence

Chemical substances that degrade slowly in the environment (i.e., are relatively resistant to biodegradation, hydrolysis and photolysis processes) are classified as persistent and represent potential

environmental problems. Persistence is measured as a half-life; the time needed to reduce the quantity of a chemical by transformation to half its initial quantity in the environment. A compound released into the environment has a tendency to partition (i.e., accumulate) into one medium (air, water, soil or sediment) more than another. Partitioning, transport and transformation rates differ in each medium. Degradation rates in the dominant medium to which the chemical has partitioned are expected to have more effect on overall persistence than degradation rates in other media.

The persistence criteria with the highest scores are based on criteria from the Persistence and Bioaccumulation Regulation (Environment Canada, 2000) A persistence value of 60 days in soil, sediment or water systems is used as a trigger value for an E2 Plan. That criteria is the same as the U.S. EPA PBT criteria used for the Toxic Release Inventory (TRI), New Substances Evaluation and other EPA programs (U.S. EPA, 1999b, c). Similar to the Persistence and Bioaccumulation Regulation, the ability to contaminate remote areas is also an E2 Plan trigger.

Table 3: Persistence of Organic Chemicals in the Environment

Air	Water/Soil	Sediments	Score	**Concern Levels**
≥ 2 days	≥ 182 days	≥ 365 days	4	Virtual elimination criteria
≥ 1 to < 2 days*	≥ 60 days*	≥ 60 days*	3	E2 Plan trigger
≥ 12 hrs to < 1 day	≥ 30 to < 60 days	≥ 30 to < 60 days	2	
≥ 6 to < 12 hrs	≥ 14 to < 30 days	≥ 14 to < 30 days	1	
< 6 hrs	< 14 days	< 14 days	0	

* or evidence of atmospheric transport to remote regions such as the Arctic (Environment Canada, 1995).

2.4.1.2 Bioaccumulation (BCF/BAF/LogK_{ow})

Bioaccumulation is the process of a chemical moving from the medium surrounding an organism (water, sediment, soil or air) or the diet into the organism from all possible exposure routes and is expressed as a bioaccumulation factor (BAF). Non-dietary bioaccumulation in aquatic organisms is referred to as bioconcentration factor (BCF). It is the process of a chemical moving from water to an organism and only considers water as the exposure medium.

The octanol-water partition coefficient K_{ow}, usually presented as a logarithm (log K_{ow}), is considered a surrogate for BCF in the simplest model of bioaccumulation. The log K_{ow} is determined in a laboratory without the use of organisms. It is a measure of how polar the substance is by determining whether the substance partitions primarily to water or to octanol. Substances that partition primarily to octanol are likely to bioaccumulate in the fat of organisms. BCF and BAF are more realistic measures of bioaccumulation than log K_{ow} and are preferred. Table 4 shows the bioaccumulation criteria used in the REF.

Table 4: Bioaccumulation of Organic Chemicals in the Environment

BCF/BAF	Log K_{ow}	Score	**Concern Levels**

≥ 5000	≥ 5	4	Virtual elimination criteria
≥ 1000 to < 5000	≥ 4 to < 5	3	E2 Plan trigger
≥ 500 to < 1000	≥ 3 to < 4	2	
≥ 50 to < 500	≥ 2 to < 3	1	
0 to < 50	< 2	0	

The E2 Plan bioaccumulation trigger value agrees with the US EPA's PBT criteria (U.S. EPA 1999 b, c). This criterion is in keeping with the stated goal of maintaining North American harmonization on environmental criteria.

2.4.1.3 Toxic Endpoints

2.4.1.3.1 Aquatic Toxicity

Freshwater and marine species toxicity data are considered equivalent and toxicity data for fish, crustaceans and algae/aquatic plants are utilized. Many substances have different toxicities in fresh and marine waters, but that which is most toxic will be considered for classification.

Acute toxicity is determined using a fish 96 hour LC_{50}, crustacean 48 hour EC_{50} and/or algal species 72 or 96 hour IC_{50}. Scoring for acute toxicity of aquatic species should be based on the summary tables produced in the data gathering document (Environment Canada, 2002a). The summary tables list the geometric means of the freshwater or marine fish, invertebrate or plant species. The geometric mean of the data for the most sensitive species is used in the REF criteria tables. When possible, only data on Canadian species should be used. Non-Canadian species should only be used when no Canadian data is available. Table 5 shows the criteria table with its corresponding scale and a trigger value, which is used in the REF.

Table 5: Acute Toxicity Rating for Aquatic Species

Category	Aquatic Toxicity (mg/L)*	Score	Concern Levels
Extremely Toxic	≤ 0.1	4	
Highly Toxic	> 0.1 to ≤ 1	3	E2 plan trigger
Moderately Toxic	>1 to ≤10	2	
Slightly Toxic	>10 to ≤100	1	
Practically Non-Toxic	>100	0	

* 96-h LC_{50} or 48-h EC_{50} or 72- or 96-h IC_{50}

2.4.1.3.2 Ingestion Toxicity

The toxicity rating for ingestion LD_{50} was modified from a draft U.S. EPA toxicity rating for pesticides using rats (U.S. EPA, 1992). A rating labeled Super toxic for compounds < 5 mg/kg of body weight was not included in this rating system. The criteria are based on dosages at which 50% of the test species die.

Table 6: Oral Rat LD_{50} Toxicity Rating

Category	Rat LD_{50} (mg/kg)[1]	Score	Concern Levels
Extremely Toxic	< 50	4	E2 plan trigger
Very Toxic	≥ 50 to < 500	3	
Moderately Toxic	≥ 500 to < 5000	2	
Slightly Toxic	≥ 5000 to < 15000	1	
Practically Nontoxic	≥ 15000	0	

1. Doses are in units of mg of toxicant per kg of body mass (U.S. EPA, 1992)

2.4.2 Human Hazard Ratings

2.4.2.1 Inhalation Toxicity

In the U.S. Clean Air Act it specifies that a chemical must have a vapour pressure of greater than or equal to10 mm Hg (1.33 kPa) before it will be considered for the Risk Management Program. The REF uses the same cut off value for vapour pressure prior to determining the human inhalation risk. In determining human inhalation toxicity risk there are three types of data considered;

- Acute Exposure Guideline Level II, 1 hour exposure (AEGL),

AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3 of air) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape. (National Research Council, 2001)

- Emergency Response Planning Guidelines Level II, 1 hour exposure (ERPG),

ERPG-2 The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action; (U.S. Department of Energy, 2001)

- Short Term Exposure Levels (15 minutes) (STEL).

STEL The concentration to which workers can be exposed continuously for a short period of time (usually 10 or 15 minutes) without suffering from: irritation; chronic or irreversible tissue damage; or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency (U.S. Occupational Safety and Health Administration, 1971).

These are non-life-threatening criteria that pertain to the effects of inhalation of chemicals by humans. The order of preference is the same as the data types listed. For details on each data type see below. For more details on these criteria see Section 4.3, Appendix.

Table 7: AEGL-2 (1 hr)/ERPG-2/STEL Criteria

Value (ppm)	Score	Concern Levels
≤ 5	4	E2 trigger value
> 5 to ≤ 50	3	
> 50 to ≤ 500	2	
> 500 to ≤ 5000	1	
> 5000	0	

2.4.2.2 Dermal Toxicity

Skin exposure to chemicals is fairly common in an environmental emergency scenario. Dermal toxicity differs from a skin sensitivity or damage rating in that some chemicals may not be corrosive to the skin, for example phenol, but are highly toxic through dermal absorption. The U.S. EPA uses the following for rating dermal toxicity based on tests with rats and rabbits (U.S. EPA, 1998). These values are extrapolated to humans with the assumption that humans will absorb the chemicals at the same rate that rats and rabbits do.

Table 8: Rat/Rabbit Toxicity Rating

Toxicity Rating	Rat/Rabbit LD_{50} (mg/kg)	Score	Concern Levels
Very Toxic	≤ 200	4	E2 plan trigger
Moderately Toxic	>200 to ≤ 2000	3	
Slightly Toxic	>2000 to ≤ 5000	2	
Practically Nontoxic	>5000 to ≤ 20000	1	
Nontoxic	> 20000	0	

2.4.2.3 Carcinogenicity

There are two sets of carcinogenicity ratings that are often listed; the International Agency for Research on Cancer (IARC, 2002), Table 9, and the U.S. EPA (2002), Table 10. Both systems use a multi-level grading system to rate a chemical's carcinogenicity potential. In these schemes a chemical is carcinogenic to humans, probably carcinogenic, carcinogenic in animals and could be carcinogenic to humans, is unclassifiable; or is not carcinogenic. In each case a gradated scoring system is used so that compounds classified as possibly carcinogenic are rated from 0 to 4. If the two systems disagree on a chemical's rating, the most conservative assessment will be used, and score the chemical accordingly.

Table 9: IARC Carcinogenicity Classifications

Descriptor	Score	Concern Levels
Group 1:The agent (mixture) is carcinogenic to humans. The exposure circumstance entails exposures that are carcinogenic to humans.	4	

Group 2A: The agent (mixture) is probably carcinogenic to humans. The exposure circumstance entails exposures that are probably carcinogenic to humans.	3	E2 Plan Trigger
Group 2B: The agent (mixture) is possibly carcinogenic to humans. The exposure circumstance entails exposures that are possibly carcinogenic to humans.	2	
Group 3: The agent (mixture, or exposure circumstance) is unclassifiable as to carcinogenicity in humans.	1	
Group 4: The agent (mixture, exposure circumstance) is probably not carcinogenic to humans.	0	

Table 10: U.S. EPA Carcinogenicity Classifications

Descriptor	Score	Concern Levels
Carcinogenic to humans	4	
Likely to be carcinogenic to humans	3	E2 Plan Trigger
Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential	2	
Data are inadequate for an assessment of human carcinogenic potential	1	
Not likely to be carcinogenic to humans	0	

2.4.2.4 Corrosion/Skin Irritation

This parameter is based on Wilson's Risk Scale of Material Hazards (Genium, 1999) and is basically a measure of corrosiveness. In general, if a chemical has a pH less than 2 or greater than 11.5 it is likely going to present an immediate corrosion hazard to exposed skin, which has been assigned a rating of 4. The rating system represents a material's degree of hazard based on documented values and/or the best judgments of certified industrial hygienists.

Table 11: Skin Corrosion/Irritation Rating

Skin Contact	Score	Concern Levels
Corrosive to skin on contact	4	E2 Plan trigger
Severe irritation; tissue corrosion within short time period	3	
Mild irritation; reversible tissue damage	2	

Slight or no irritation; no tissue damage	1	
Not applicable	0	

2.4.3 Physical Hazard Ratings

2.4.3.1 Flammability Hazard

There are several factors that can determine a substance's flammability, the most important being the flash and boiling points. The boiling point is the temperature at which the vapour pressure of a liquid exceeds atmospheric pressure. Since atmospheric pressure can no longer keep the substance in the liquid state, bubbles begin to form and the material converts into a vapour. Boiling point provides us a relative index of a liquid's volatility. Liquids with a low boiling point are readily converted to vapour phase, thus creating, for example, an inhalation hazard or a flammable, explosive mixture.

Boiling Point is required in most hazard assessments. Many organic compounds have boiling points lower than or within the range of ambient Canadian conditions (-40 to 40 ºC) so that they may be stored or shipped as liquids under pressure and are called compressed liquids. Propane is a good example of this kind of organic chemical. They will remain in the liquid state only under pressure. In accident scenarios a pressurized container may be ruptured causing the rapid expansion of the chemical into the gaseous phase. Under intense heat a pressurized container may not be able to maintain the liquid in that state, the gas pressure builds leading to an extremely hazardous situation called a Boiling Liquid Expanding Vapour Explosion (BLEVE) when the pressure container ruptures.

Flash point is defined as the lowest temperature at which a flammable liquid gives off sufficient vapour to form an ignitable mixture with air near its surface or within a vessel. Flash point is an important factor when considering the safety of spill cleanup operations.

Flammability classes are determined primarily by flash point and boiling point; however, there are some products that are placed in flammability classes based on other criteria. For example, products that create fine dusts may be extremely explosive when ignited due to the large surface area of the dust (see Table 13 for the detailed flammability classifications).

There is a trigger value for an environmental emergency plan for any chemical that scores a 4, as these chemicals are inherently very hazardous. This set of criteria is from the U.S. National Fire Protection Association (2002).

Table 12: Abbreviated NFPA Flammability Classes

Flammability Class	Score	Concern Levels
Class IA - Flash Point less than 73°F (22.8 ºC); Boiling Point less than 100°F (37.8 ºC)	4	E2 Plan trigger

Class IB - Flash Point less than 73°F (22.8 ºC); Boiling Point equal to or greater than 100°F (37.8 ºC)	3	
Class IC - Flash Point equal to or greater than 73°F (22.8 ºC), but less than 100°F (37.8 ºC)	3	
Class II – Flash Point equal to or greater than 100°F (37.8 ºC), but less than 140°F (60 ºC)	2	
Class IIIA - Flash Point equal to or greater than 140°F (60 ºC), but less than 200°F (75.6 ºC)	1	
Class IIIB - Flash Point equal to or greater than 200°F (75.6 ºC)	1	
Materials that will not burn (when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes)	0	

Table 13: Detailed Flammability Ratings

Hazard Description	Score	Concern Levels
Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or which are readily dispersed in air, and which will burn readily. This degree should include: • Gases; • Cryogenic materials; • Any liquid or gaseous material which is a liquid while under pressure and have a flash point below 73°F (22.8°C) and having a boiling point below 100°F(37.8°C). (**Class IA flammable liquids**.) • Materials which on account of their physical form or environmental conditions can form explosive mixtures with air and which are readily dispersed in air, such as dusts of combustible solids and mists of flammable or combustible liquid droplets.	4	E2 Plan trigger
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. This degree should include: • Liquids having a flash point below 73°F (22.8°C) and	3	

having a boiling point at or above 100°F (37.8°C) and those liquids having a flash point at or above 73°F (22.8°C) and below 100°F (37.8°C). (**Class IB and Class IC flammable liquids**); • Solid materials in the form of coarse dusts which may burn rapidly but which generally do not form explosive atmospheres with air; • Solid materials in a fibrous or shredded form which may burn rapidly and create flash fire hazards, such as cotton, sisal and hemp; • Materials which burn with extreme rapidity, usually by reason of self-contained oxygen (e.g., dry nitrocellulose and *many organic peroxides*); • Materials which ignite spontaneously when exposed to air.		
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 may release vapor in sufficient quantities to produce hazardous atmospheres with air. This degree should include: • Liquids having a flash point above 100°F (37.8°C), but not exceeding 200°F (93.4°F) (**Classes II and IIIa**); • Solids and semisolids which readily give off flammable vapors.	2	
Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature condition, before ignition and combustion can occur. This degree should include: • Materials which will burn in air when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes or less; • Liquids, solids, and semisolids having a flash point above 200°F (93.4°C) (**Class IIIb**); This degree includes most ordinary combustible materials.	1	
Materials that will not burn. This degree should include any material which will not burn in air when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes.	0	

2.4.3.2 Instability

Some chemicals are extremely unstable, requiring special handling procedures or containers to isolate them from conditions and chemicals that they might react with. These substances can be extremely hazardous in an emergency situation, especially those that react explosively with water. The rating system is also from the U.S. National Fire Protection Association (2002). The top class of substance with an assigned value of 4 (Materials which in themselves are readily capable of detonation …) is given a trigger value for requiring an Environmental Emergency Plan due to the extreme hazard associated with such chemicals.

Table 14: Instability Rating

Hazard Description	Score	Concern Levels
Materials which in themselves are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. This degree should include materials which are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.	4	E2 Plan trigger
Materials which in themselves are capable of detonation or of explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This degree should include materials which are sensitive to thermal or mechanical shock at elevated temperatures and pressures or which react explosively with water without requiring heat or confinement.	3	
Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This degree should include materials which can undergo chemical change with rapid release of energy at normal temperatures and pressures or which can undergo violent chemical change at elevated temperatures and pressures. It should also include those materials which may react violently with water or which may form potentially explosive mixtures with water.	2	
Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently.	1	
Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.	0	

2.4.3.3 Hazardous Decomposition Products

This parameter has been assigned a Yes/No designation; either the compound will generate hazardous decomposition products upon heating, combustion or exposure to water or it will not. Such decomposition products can be extremely toxic, in some cases much more so than the parent material. This

parameter is included under physical hazards as there are many different types of decomposition products, some are toxic and some are also hazardous to physical structures.

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4 APPENDICES

4.1 Section 199 of CEPA, 1999

Section 199 of Canadian Environmental Protection Act, 1999 states, in part:

(1) The Minister may at any time publish in the Canada Gazette, and in any other manner that the Minister considers appropriate, a notice requiring any person or class of persons described in the notice to prepare and implement an environmental emergency plan respecting the prevention of, preparedness for, response to or recovery from an environmental emergency in respect of

(a) a substance or group of substances on the List of Toic Substances in Schedule 1;

or

(b) a substance or group of substances in relation to which there has been published in the Canada Gazette

(c) a statement of the Ministers under paragraph 77(6)(b) indicating that the measure that they propose to take, as confirmed or amended, is a recommendation that the substance be added to the List of Toxic Substances in Schedule 1,

or

(ii) a copy of an order proposed to be made under subsection 90(1).

(2) The notice shall specify

(a) the substance or group of substances in relation to which the plan is to be prepared;

(b) the period within which the plan is to be prepared;

(c) the period within which the plan is to be implemented; and

(d) any other matter that the Minister considers necessary.

4.2 Section 200 of CEPA, 1999

Section 200 of CEPA, 1999 states:

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;

(a) prescribing, in respect of a substance on the list established under paragraph (a), a minimum quantity;

(b) 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;

(c) respecting the prevention of, preparedness for, response to and recovery from an environmental emergency in respect of a substance;

(d) respecting the notification and reporting of an environmental emergency;

(e) 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;
(a) respecting the implementation of international agreements entered into by Canada in relation to environmental emergencies; and
(b) respecting any other matter necessary for the purposes of this part.

(2) The Governor in Council shall not make a regulation under subsection (1) in respect of a matter if, by order, the Governor in Council states that it is of the opinion that
    (a) the matter is regulated by or under any other Act of Parliament that contains provisions that are similar in effect to sections 194 to 205; and
    (b) that Act or any regulation made under that Act provides sufficient protection to human health and the environment or its biological diversity.

4.3 Details on Human Inhalation Toxicity Measurements

4.3.1 AEGL

The U.S. EPA has shifted from using LC_{50} values to Acute Exposure Guideline Levels (AEGL) in determining relative hazards of chemicals in emergency situations. The primary purpose of the AEGL program is to develop guideline levels for once-in-a-lifetime short-term exposures to airborne concentrations of acutely toxic, high priority chemicals. A principle objective of the program is to develop scientifically credible acute (short-term) once–in-a-lifetime exposure guidelines within the constraints of data availability, resources and time. AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. It is believed that exposure levels are applicable to the general public, including susceptible groups, such as infants, children, the elderly, persons with asthma, and those with other illnesses. However, it is recognised that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL (National Research Council, 2001).

For each chemical exposure levels are developed for a minimum of five exposure periods (10 minutes, 30 minutes, 1 hour, 4 hours, 8 hours). In addition, for each exposure period, three levels or "tiers" representing different severity of toxic effects are established as follows:

AEGL-1 is the airborne concentration (expressed as ppm or mg/m^3 of air) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort.

AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3 of air) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration (expressed as ppm or mg/m^3 of air) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

The U.S. EPA envisions that AEGLs will be applied in the areas of emergency preparedness and response, chemical accident prevention in transportation and fixed facilities, worker safety, contaminated site remediation, destruction of chemical warfare agents, and chemical terrorism counter activities. The development of AEGLs has been slow due to the amount of work it takes to generate a final value, to date there are AEGLs for only 26 chemicals. In the REF the AEGL 2, 1-hour exposure is used, as it should correspond with an ERPG 2 value (see below).

4.3.2 ERPG

The U.S. Department of Energy Chemical Safety Program uses Emergency Response Planning Guidelines (ERPGs) to assess the threat to humans from chemicals in air (U.S. DOE, 2001). The concentrations given are designed to be a warning of potential health effects, but are not lethal concentrations. There are three levels; one being the lowest is correlated with minor transient effects, while 3 is associated with serious, but non-life threatening effects. Theoretically, an AEGL 1-hour value and a corresponding ERPG value should be the same for a chemical, although in practice there are differences based on the interpretation of data.

ERPG-1 The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor;

ERPG-2 The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action;

ERPG-3 The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

The ERPG 2 value was used as the starting point and from there the ranges of chemical concentrations were divided into 5 categories. The value 0.5 ppm was chosen as the lowest concentration as this is the value that the U.S. EPA chose as a criterion for inhalation toxicity to include a chemical on their RMP list, although in that case they used an LC_{50} 4-hour exposure. In the REF the top two scores are multiplied by 5 to increase the importance of this parameter in the overall score.

An AEGL/ERGP 2 concentration that is ≤ 5 ppm is used as a single criterion for requiring an E2 Plan, regardless of other data. It was felt that these compounds could be extremely toxic to humans via inhalation so that any sort of spill involving them is a high-risk situation and thus should have an E2 Plan. In comparison with the U.S. EPA criteria for inclusion on the RMP list (LC_{50} 4-hr exposure) this trigger value is more conservative as it is a non-lethal criterion although it is over a shorter exposure period. This scale is shown in Table 4 below.

4.3.3 OSHA STEL

The U.S. Occupational Safety and Health Administration develop Short Term Exposure Levels (STEL) in cooperation with the U.S. National Institute of Occupational Safety and Health (U.S. Occupational Safety and Health Administration, 1971). These values represent concentrations in air that are of significant hazard to exposed workers over a 15-minute time period, but are not lethal values. They can be inhaled or absorbed through the skin. A STEL is defined by the American Council of Governmental Industrial Hygienists as the concentration to which workers can be exposed continuously for a short period of time (usually 10 or 15 minutes) without suffering from: irritation; chronic or irreversible tissue damage; or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency. A STEL is typically a 10 or 15 minute exposure and is therefore more conservative than an equivalent AEGL 2 or ERPG 2 that are set for a 1 hour exposure, although they are often based on the interpretation of different data.