ERG2020 USER'S GUIDE

For the purposes of this guidebook, the terms hazardous materials/dangerous goods are synonymous.

The 2020 Emergency Response Guidebook (ERG2020) was developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT), and the Secretariat of Communications and Transport of Mexico (SCT), with help from CIQUIME (Centro de Información Química para Emergencias) of Argentina.

This guidebook is for firefighters, police and other emergency services personnel who may be first to arrive at the scene of a transportation incident involving dangerous goods.

It is primarily a guide to help first responders to quickly:

- **identify the specific or generic hazards of material(s) involved in a transportation incident**
- **protect themselves and the general public during the initial response phase of the incident**

For the purposes of this guidebook, "initial response phase" is the period after first responders arrive at the scene of an incident. During this phase, responders:

- confirm the presence and/or identification of dangerous goods
- start taking protective action and securing the area
- request the help of qualified personnel

This guide is designed for use at a dangerous goods incident on a highway or railroad. It may have limited value at fixed-facility locations, or onboard aircrafts or vessels.

This guide **does not:**

- provide information on the physical or chemical properties of dangerous goods
- replace emergency response training, knowledge, or sound judgment
- address all possible circumstances that may be associated with a dangerous goods incident

ERG2020 incorporates dangerous goods lists from the most recent United Nations Recommendations, and from other international and national regulations.

Explosives are not listed individually (by either proper shipping name or ID number) but, under the general heading "Explosives", they do appear:

- on the first page of the ID Number index (yellow-bordered pages)
- alphabetically in the Name of Material index (blue-bordered pages)

Chemical warfare agents do not have an assigned ID number because they are not commercially transported. In an emergency situation, the assigned guide (orange-bordered pages) will provide guidance for the initial response.

The letter **(P)** following the guide number in the yellow and blue bordered pages identifies materials that present a polymerization hazard under certain conditions. For example: UN1092 - Acrolein, stabilized GUIDE **131P**.

First responders at the scene of a dangerous goods incident should not solely rely on this guidebook. Always seek specific information about any material in question as soon as possible. To do so:

- Contact the appropriate emergency response agency listed on the inside back cover.
- Call the emergency response telephone number on the shipping paper.
- Consult information on or accompanying the shipping paper.

BEFORE AN EMERGENCY – BECOME FAMILIAR WITH THIS GUIDEBOOK! In the U.S., according to the requirements of the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA, 29 CFR 1910.120) and regulations issued by the U.S. Environmental Protection Agency (EPA, 40 CFR Part 311), first responders must be trained in how to use this guidebook.

GUIDEBOOK CONTENTS

1- Yellow-bordered pages: Index list of dangerous goods in order of ID number. The list displays the 4-digit ID followed by its assigned emergency response guide and material name.

For example:	ID No.	GUIDE No.	Name of Material
	1090	127	Acetone

2- Blue-bordered pages: Index list of dangerous goods in alphabetical order of material name. The list displays the name followed by its assigned emergency response guide and 4-digit ID number.

For example:	Name of Material	GUIDE No.	ID No.
	Sulfuric acid	137	1830

3- Orange-bordered pages: All safety recommendations are provided here. It is made up of 62 individual guides in a 2-page format. Each guide recommends safety and emergency response procedures to protect yourself and the public. The left-hand page gives safety-related information and evacuation distances. The right-hand page gives emergency response guidance for fires, spills or leaks, and first aid. Each guide applies to a group of materials with similar chemical and toxicological characteristics. The guide title identifies the general hazards of the dangerous goods.

For example: GUIDE 124 - **Gases - Toxic and/or Corrosive - Oxidizing**.

Each guide is divided into 3 main sections:

POTENTIAL HAZARDS:

- Displays the hazards in terms of **FIRE OR EXPLOSION** and **HEALTH** effects upon exposure.
- Primary potential hazard is listed first.
- Consult this section first to help you make decisions about how to protect the emergency response team and surrounding population.

PUBLIC SAFETY:

- Provides general information on initial precautionary measures to be taken by those first on scene.
- Provides general guidance on **PROTECTIVE CLOTHING** requirements and respiratory protection.
- Lists suggested **EVACUATION** distances for immediate precautionary measures, spills, and for fires (fragmentation hazard).
- When the material is highlighted in green in the yellow and blue bordered pages, it directs the reader to consult Table 1, which lists Toxic Inhalation Hazard (TIH) (PIH in the U.S.) materials, water-reactive materials and chemical warfare agents (green-bordered pages).

EMERGENCY RESPONSE:

- Outlines special precautions for incidents that involve **FIRE**, **SPILL OR LEAK** or chemical exposure.
- Lists several recommendations under each part to further assist your decision-making process.
- Provides general **FIRST AID** guidance to use before seeking medical care.

4- Green-bordered pages: This section has 3 tables.

Table 1 - Initial Isolation and Protective Action Distances

Lists, by order of ID number:

- TIH (PIH in the U.S.) materials
- water-reactive materials that produce toxic gases upon contact with water
- certain chemical warfare agents

These materials are highlighted in green in the yellow and blue bordered pages so you can easily identify them.

Table 1 provides two types of recommended safety distances: **"initial isolation distances"** and **"protective action distances"** for:

- **small spills**: 208 liters (55 US gallons) or less
- **large spills**: more than 208 liters (55 US gallons)
- Exception: For entries marked **(when used as a weapon)**, volumes vary, but in most cases, small spills include releases up to 2 kg (4.4 lbs.), and large spills include releases up to 25 kg (55 lbs.).

Within the **"initial isolation distance"**, protective clothing and respiratory protection is required. You should consider evacuating all people **in all directions** from the spill or leak source. This distance defines the radius of the "initial isolation zone" surrounding the spill in which people may be exposed to:

- dangerous concentrations upwind of the source
- life-threatening concentrations downwind of the source

The **"protective action distances"** are downwind distances from the spill or leak source, within which responders could carry out protective actions to:

- preserve the health and safety of emergency responders and the public
- evacuate and/or shelter-in-place people in this area (For more information, consult pp. 289 to 291)

The "protective action distance" is divided into **daytime** and **nighttime** incidents because varying atmospheric conditions affect a hazardous area's size. In fact, the quantity or concentration of the material's vapor poses problems, not its mere presence. During the night, the air is generally calmer. This causes the vapor to disperse less and therefore creates a greater toxic zone. In daytime, the atmosphere is more active, so the vapor disperses more. As a result, there is a lower concentration of vapor in the surrounding air and the area that reaches toxic levels is smaller. Daytime is after sunrise and before sunset. Nighttime is between sunset and sunrise.

For example, in the case of a small spill of UN1955 - compressed gas, toxic, n.o.s., the **"initial isolation distance"** is 100 meters (300 feet); therefore its "initial isolation zone" is 200 meters (600 feet) in diameter. Its **"protective action distance"** is 0.5 kilometers (0.3 miles) for daytime and 2.5 kilometers (1.6 miles) for nighttime.

Note 1: Some water-reactive materials have 2 entries in Table 1. They are identified by **(when spilled on land)** since they are TIH products and **(when spilled in water)** because they produce additional toxic gases when spilled in water.

For example: UN1746 - Bromine trifluoride and UN1836 - Thionyl chloride.

Note 2: If a water-reactive material only has one entry in Table 1 for **(when spilled in water)** and the product is NOT spilled in water, Table 1 and Table 2 do not apply. You will find safe distances in the appropriate orange-bordered guide.

For example: UN1183 - Ethyldichlorosilane and UN1898 – Acetyl iodide.

Table 2 - Water-Reactive Materials Which Produce Toxic Gases

Lists:

- by order of ID number, materials that produce large amounts of Toxic Inhalation Hazard (TIH) gases when spilled in water; and
- TIH gases produced by these materials.

You can easily identify water-reactive materials in **Table 1,** as their names are immediately followed by **(when spilled in water).**

NOTE: The TIH gases indicated in Table 2 are for information purposes only. These TIH gases have already been taken into consideration in the distances of Table 1.

For example, Table 2 indicates that UN1689 sodium cyanide, when spilled in water, will generate hydrogen cyanide gas (HCN). In Table 1, you must refer to the distances for sodium cyanide, solid and not the distances for hydrogen cyanide gas.

Table 3 - Initial Isolation and Protective Action Distances for Large Spills for Different Quantities of Six Common TIH Gases

Lists the following 6 most common TIH materials:

- UN1005 - Ammonia, anhydrous
- UN1017 - Chlorine
- UN1040 - Ethylene oxide and UN1040 - Ethylene oxide with nitrogen
- UN1050 - Hydrogen chloride, anhydrous and UN2186 - Hydrogen chloride, refrigerated liquid
- UN1052 - Hydrogen fluoride, anhydrous
- UN1079 - Sulfur dioxide/Sulphur dioxide

Table 3 shows:

- initial isolation and protective action distances for large spills (more than 208 liters or 55 US gallons)
- different container types (therefore different volume capacities) for daytime and nighttime, and for three different wind speeds (low, moderate and high)

HOW TO CHOOSE THE APPROPRIATE ISOLATION AND PROTECTIVE ACTION DISTANCES

ERG2020 lists isolation or evacuation distances in 2 places:

- the individual guides (orange-bordered pages)
- Table 1 – Initial Isolation and Protective Action Distances (green-bordered pages)

If you are dealing with a **non-TIH material** (not highlighted in green in the yellow-bordered or blue-bordered pages),

- Go to the assigned guide for the material (orange-bordered pages).
- Under **EVACUATION**, you will find:
  - initial isolation distance as an immediate precautionary measure
  - specific distances for spill or fire situations (fragmentation hazard)
  - **Please note** that certain guides may also refer to Table 1. This is just a reminder for green highlighted materials only.

If you are dealing with a **TIH, water-reactive** or **chemical warfare** material (green highlighted entries in the yellow or blue bordered pages):

If there is no fire:

- Go directly to Table 1 – Initial Isolation and Protective Action Distances (green-bordered pages).
- Also, consult the assigned guide for the material (orange-bordered pages).

If a fire is involved:

- Go directly to the assigned guide (orange-bordered pages) and apply the distances found under **EVACUATION** - Fire.
- Also, consult Table 1 distances for residual material release.

PROTECTIVE CLOTHING

STREET CLOTHING AND WORK UNIFORMS

These garments, such as uniforms worn by police and emergency medical services personnel, provide almost no protection from the harmful effects of hazardous materials/dangerous goods.

STRUCTURAL FIREFIGHTERS' PROTECTIVE CLOTHING (SFPC)

This category of clothing, often called turnout or bunker gear, is the protective clothing firefighters normally wear during structural firefighting operations. It includes a helmet, coat, pants, boots, gloves and a hood to cover parts of the head that are not protected by the helmet and facepiece. It can be used with full-facepiece positive pressure self-contained breathing apparatus (SCBA). It should, at minimum, meet the OSHA Fire Brigades Standard (29 CFR 1910.156) or NFPA 1851.

Structural firefighters' protective clothing provides limited protection from heat and cold. It may not provide adequate protection from harmful vapors or liquids encountered during hazardous materials/dangerous goods incidents.

Each guide includes a statement about the use of SFPC in incidents involving the materials referenced by that guide. Some guides state that SFPC provides limited protection. In those cases, the responder wearing SFPC and SCBA may be able to perform a quick "in-and-out" operation. However, this type of operation can place the responder at risk of exposure, injury or death. The incident commander makes the decision to do this only if there is an overriding benefit (for example, to perform an immediate rescue, turn off a valve to control a leak, etc.).

Please note that the coverall-type protective clothing customarily worn to fight fires in forests or wildlands is not SFPC and **is not** recommended nor referred to elsewhere in this guidebook.

POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SCBA)

This apparatus provides a constant, positive pressure flow of air within the facepiece.

You should always use an SCBA certified by NIOSH and the Department of Labor/Mine Safety and Health Administration, in accordance with:

- 42 CFR Part 84
- requirements for respiratory protection specified in OSHA 29 CFR 1910.134 (Respiratory Protection) and/or 29 CFR 1910.156 (f) (Fire Brigades Standard)
- NFPA 1852

Chemical-cartridge respirators or other filtering masks are not acceptable substitutes for positive pressure SCBA. Demand-type SCBA does not meet the OSHA 29 CFR 1910.156 (f)(1)(i) of the Fire Brigades Standard.

RESPIRATORS

If you suspect a chemical warfare agent is involved in an incident, use NIOSH-certified respirators with CBRN protection.

N95 respirators are the most common of the seven types of particulate filtering facepiece respirators. This product filters at least 95% of airborne particles (0.3 microns), but is not resistant to oil. N95 filtering facepiece respirators do not protect against gases and vapors.

Powered air-purifying respirators (PAPR) force ambient air through the air-purifying cartridge or filter into the facepiece. A PAPR does not supply oxygen or air from a separate source (e.g., cylinders).

CHEMICAL PROTECTIVE CLOTHING AND EQUIPMENT

For you to safely use this type of protective clothing and equipment, you need specific skills developed through training and experience. This type of special clothing may protect against one chemical but be readily permeated by chemicals for which it was not designed. Therefore, do not use this type of protective clothing unless it is compatible with the released material. Also, be aware that it offers little or no protection against heat and/or cold.

Examples of this type of equipment have been described as:

(1) Vapor Protective Suits (NFPA 1991), also known as Totally-Encapsulating Chemical Protective Suits or Level A* protection (OSHA 29 CFR 1910.120, Appendix A & B)

(2) Liquid-Splash Protective Suits (NFPA 1992), also known as Level B* or C* protection (OSHA 29 CFR 1910.120, Appendix A & B), or suits for chemical/biological terrorism incidents (NFPA 1994), class 1, 2 or 3 Ensembles and Standard CAN/CGSB/CSA-Z1610-11 – Protection of first responders from chemical, biological, radiological, and nuclear (CBRN) events

No single protective clothing material will protect you from all hazardous materials/dangerous goods. Do not assume any protective clothing is resistant to cold and/or heat or flame exposure, unless certified by the manufacturer (NFPA 1991 5-3 Flammability Resistance Test and 5-6 Cold Temperature Performance Test).

*Consult the glossary for more information about protection levels under the heading “Protective Clothing.”

DECONTAMINATION

The ways to decontaminate people and equipment can vary. If you need help with decontamination, contact the emergency response telephone number provided on the shipping papers or the agencies listed on the inside back cover. These resources may be able to put you in contact with the chemical manufacturer to determine the appropriate procedure if not otherwise available.

Decontamination is the process of removing or neutralizing hazardous materials/dangerous goods that have contaminated people and equipment during an incident.

Contamination happens in the area generally referred to as the Hot Zone. Everything and everyone entering this zone should be decontaminated when leaving, including emergency response personnel. This reduces the chances that more contamination will occur.

There are two main types of contamination:

- **Direct contamination** happens in the Hot Zone.
- **Cross contamination** happens when someone or something outside the Hot Zone was not properly decontaminated and comes in contact with another object or person, usually in the Warm or Cold Zone.

To decontaminate, you must:

- physically remove contaminants; and/or
- chemically neutralize contaminants*.

The NFPA 472, Chapter 3, describes the following four kinds of decontamination.

(1) **Gross decontamination:** Quickly removing surface contamination, which usually happens by mechanically removing the contaminant or rinsing with water from handheld hose lines, emergency showers, or other nearby water sources.

(2) **Technical decontamination:** Reducing contamination to a level as low as possible by chemical or physical methods. A hazmat team will perform this kind of decontamination.

(3) **Mass decontamination:** Reducing or removing surface contaminants as fast as possible from a large number of people in potentially life-threatening situations.

(4) **Emergency decontamination:** Immediately reducing contamination of people in potentially life-threatening situations with or without formally setting up a decontamination corridor. This process should be performed upwind and uphill from victims. Responders should avoid contact with victims, runoff or spray from the decontamination process.

Emergency and mass decontamination can be done with firefighting and rescue operations equipment. Nozzles can be put on wide-angle fog patterns and sprayed towards the ground to create a decontamination shower. Responders can also place nozzles on the discharge ports of engines.

Contaminated clothing and equipment must be removed after use and stored in a controlled area (Warm Zone) until cleanup procedures can begin. Sometimes protective clothing and equipment cannot be decontaminated and must be disposed of properly.

*Chemical neutralization releases heat. DO NOT PERFORM on a victim.

FIRE CONTROL

Water is the most common and generally most available fire extinguishing agent. Use caution in selecting a fire extinguishing method, as there are many factors to consider. Water may be ineffective in fighting fires that involve some materials.

Fires Involving a Spill of Flammable Liquids

These fires are usually controlled by applying a firefighting foam to the surface of the burning material.

Fighting flammable liquid fires requires:

- foam concentrate that is chemically compatible with the burning material
- correct mixing of the foam concentrate with water and air
- careful application and maintenance of the foam blanket

There are two general types of firefighting foam: regular and alcohol-resistant. Examples of regular foam are protein-base, fluoroprotein, and aqueous film-forming foam (AFFF).

You can control some flammable liquid fires, including many petroleum products, by applying regular foam. Other flammable liquids, including polar solvents (flammable liquids that are water soluble), such as alcohols and ketones, have different chemical properties. You cannot easily control a fire that involves these materials with regular foam, and should use alcohol-resistant foam instead.

Polar solvent fires may be difficult to control and require a higher foam application rate than other flammable liquid fires (see NFPA Standards 11 for further information). Refer to the appropriate guide to determine which type of foam to use. For flammable liquids which have subsidiary corrosive or toxic hazards, it is difficult to make specific recommendations. However, alcohol-resistant foam may be effective for many of these materials.

Contact the emergency response telephone number on the shipping paper, or the appropriate emergency response agency, as soon as possible for guidance on the proper fire extinguishing agent to use.

How you decide to control the fire depends on factors such as:

- incident location
- exposure hazards
- size of the fire
- environmental concerns
- availability of extinguishing agents and equipment at the scene

WATER-REACTIVE MATERIALS

Water is sometimes used to flush spills and reduce or direct vapors in spill situations. Some of the materials covered by this guidebook can react violently or even explosively with water. In these cases, consider letting the fire burn or leaving the spill alone (except to prevent its spreading by diking) until you can get more technical advice.

The applicable guides clearly warn you of these potentially dangerous reactions. Technical advice is required for these materials since:

- Water getting inside a ruptured or leaking container may cause an explosion.
- You may need to cool adjoining containers with water to prevent them from rupturing (exploding), or to prevent the fire spreading further.
- Water may be effective in mitigating an incident involving a water-reactive material, but only if you can apply it at a **sufficient flooding rate for a long period**.
- Products from the reaction with water may be more toxic, corrosive or undesirable than the product that caused the fire.

When you respond to an incident involving water-reactive materials, take into account:

- existing conditions, such as wind, precipitation, location and accessibility to the incident
- availability of agents to control the fire or spill

Because there are variables to consider, base your decision to use water on fires or spills involving water-reactive materials on information from a reliable source. For example, consult the material's manufacturer through the emergency response telephone number or the appropriate emergency response agency listed on the inside back cover.

VAPOR CONTROL

Limiting the amount of vapor released from a pool of flammable or corrosive liquids is an operational concern. It requires proper protective clothing, specialized equipment, appropriate chemical agents and skilled personnel. Before you engage in vapor control, seek advice on tactics to be used from qualified personnel.

There are several ways to minimize the amount of vapors escaping from pools of spilled liquids, such as special foams, adsorbing agents, absorbents, and neutralizing agents. To be effective, you must select a method for the specific material involved, and use it in a way that mitigates, not worsens, the incident.

Where specific materials are known, such as at a manufacturing or storage facilities, the hazardous materials/dangerous goods response team should prearrange with the facility operators to select and stockpile these control agents before a spill.

In the field, first responders may not have the most effective vapor control agent for the material available. They will be more likely to have only water, and only one type of firefighting foam on their vehicles. If the available foam is not appropriate, they will probably use water spray. Because water is being used to form a vapor seal, care must be taken not to churn or further spread the spill during application. Vapors that do not react with water may be directed away from the site using the air currents surrounding the water spray. Before using water spray or other methods to safely control vapor emission or suppress ignition, get technical advice based on a specific chemical name.

BLEVE AND HEAT INDUCED TEAR

BLEVE (BOILING LIQUID EXPANDING VAPOR EXPLOSION)

The following pages present important safety-related information on BLEVEs, including a table, to consider in a situation involving Liquefied Petroleum Gases (LPG), UN1075.

LPGs include the following flammable gases:

- UN1011 - Butane
- UN1012 - Butylene
- UN1055 - Isobutylene
- UN1077 - Propylene
- UN1969 - Isobutane
- UN1978 - Propane

A BLEVE occurs when a fire impinged or damaged tank car fails to contain its internal pressure and explodes with a sudden product release. This catastrophic failure is more likely to occur with damaged pressure tank cars, even in the absence of an active fire.

The **main hazards** from a LPG BLEVE are:

- Fire: If the released substance is ignited, there is an immediate fireball.
- Thermal radiation: At a distance of about 4 times the radius of a fireball, the heat radiated from a fireball is enough to burn exposed skin in 2 seconds. Wearing protective clothing limits the thermal radiation dose.
- Blast: A concussive force caused by the sudden release of the pressurized substance. For a BLEVE occurring out in the open, the blast strength at a distance of 4 times the radius of a fireball can break window glass and may cause minor damage to buildings.
- Projectiles: Tank failure can throw metal fragments over large distances. These fragments can and have been deadly.

The danger decreases as you move away from the BLEVE centre. The furthest-reaching hazard is projectiles.

For a video with information on critical safety issues concerning BLEVEs, please visit *http://www.tc.gc.ca/eng/tdg/publications-menu-1238.html*.

HEAT INDUCED TEAR (HIT)

A heat induced tear (HIT) is a rupture of a NON-PRESSURE tank car containing flammable liquids when exposed to the intense heat of a fire. The metal will soften and the pressure in the tank car will increase which can lead to containment failure. The tear generally occurs at the vapor space (upper side) of the container, venting large quantities of flammable liquid and vapors at high speed. A fireball and an intense heat wave will occur.

Compared to BLEVEs, HITs rarely result in the projection of tank car fragments. Heat induced tearing has occurred within 20 minutes of the derailment and as long as 10+ hours following the initial fire.

Responding to these types of incidents (BLEVE and HIT) requires specialized training, equipment and a tactical approach.

BLEVE – SAFETY PRECAUTIONS

Use with caution. The following table gives a summary of tank properties, critical times, critical distances and cooling water flow rates for various tank sizes. This table is provided to give responders some guidance but it should be used with caution.

Tank dimensions are approximate and can vary depending on the tank design and application.

Minimum time to failure is based on ***severe torch fire impingement*** on the vapor space of a tank in good condition, and is approximate. Tanks may fail earlier if they are damaged or corroded. Tanks may fail minutes or hours later than these minimum times depending on the conditions. It has been assumed here that the tanks are not equipped with thermal barriers or water spray cooling.

Minimum time to empty is based on an engulfing fire with a properly sized pressure relief valve. If the tank is only partially engulfed, then time to empty will increase (i.e., if tank is 50% engulfed, then the tanks will take twice as long to empty). Once again, it has been assumed that the tank is not equipped with a thermal barrier or water spray.

Tanks equipped with thermal barriers or water spray cooling significantly increase the times to failure and the times to empty. A thermal barrier can reduce the heat input to a tank by a factor of ten or more. This means it could take ten times as long to empty the tank through the Pressure Relief Valve (PRV).

Fireball radius and emergency response distance is based on mathematical equations and is approximate. They assume spherical fireballs and this is not always the case.

Two safety distances for public evacuation. The minimum distance is based on tanks that are launched with a small elevation angle (i.e., a few degrees above horizontal). This is most common for horizontal cylinders. The preferred evacuation distance has more margin of safety since it assumes the tanks are launched at a 45 degree angle to the horizontal. This might be more appropriate if a vertical cylinder is involved.

It is understood that these distances are very large and may not be practical in a highly populated area. However, it should be understood that the risks increase rapidly the closer you are to a BLEVE. Keep in mind that the furthest reaching projectiles tend to come off in the zones 45 degrees on each side of the tank ends.

Water flow rate is based on 5 ($\sqrt{\text{capacity (USgal)}}$) = USgal/min needed to cool tank metal.

Warning: the data given are approximate and should only be used with extreme caution. For example, where times are given for tank failure or tank emptying through the pressure relief valve – these times are typical but they can vary from situation to situation. Therefore, never risk life based on these times.

WARNING: The data given are approximate and should only be used with extreme caution. These times can vary from situation to situation. LPG tanks have been known to BLEVE within minutes. Therefore, never risk life based on these times.

BLEVE
(USE WITH CAUTION)

Capacity		Diameter		Length		Propane Mass		Minimum time to failure for severe torch	Approximate time to empty for engulfing fire	Fireball radius		Emergency response distance		Minimum evacuation distance		Preferred evacuation distance		Cooling water flow rate	
Litres	(Gallons)	Meters	(Feet)	Meters	(Feet)	Kilograms	(Pounds)	Minutes	Minutes	Meters	(Feet)	Meters	(Feet)	Meters	(Feet)	Meters	(Feet)	Litres/min	USgal/min
100	(26.4)	0.3	(1)	1.5	(4.9)	40	(88)	4	8	10	(33)	90	(295)	154	(505)	307	(1007)	97	26
400	(106)	0.61	(2)	1.5	(4.9)	160	(353)	4	12	16	(53)	90	(295)	244	(801)	488	(1601)	195	51
2000	(528)	0.96	(3.2)	3	(9.8)	800	(1764)	5	18	28	(92)	111	(364)	417	(1368)	834	(2736)	435	115
4000	(1057)	1	(3.3)	4.9	(16.1)	1600	(3527)	5	20	35	(115)	140	(459)	525	(1722)	1050	(3445)	615	163
8000	(2113)	1.25	(4.1)	6.5	(21.3)	3200	(7055)	6	22	44	(144)	176	(577)	661	(2169)	1323	(4341)	870	230
22000	(5812)	2.1	(6.9)	6.7	(22)	8800	(19400)	7	28	62	(203)	247	(810)	926	(3038)	1852	(6076)	1443	381
42000	(11095)	2.1	(6.9)	11.8	(38.7)	16800	(37037)	7	32	77	(253)	306	(1004)	1149	(3770)	2200	(7218)	1994	527
82000	(21662)	2.75	(9)	13.7	(45)	32800	(72310)	8	40	96	(315)	383	(1257)	1435	(4708)	2200	(7218)	2786	736
140000	(36984)	3.3	(10.8)	17.2	(56.4)	56000	(123457)	9	45	114	(374)	457	(1499)	1715	(5627)	2200	(7218)	3640	962

CRIMINAL OR TERRORIST USE OF CHEMICAL, BIOLOGICAL AND RADIOLOGICAL AGENTS

If you suspect an intentional release of a chemical, biological or radiological agent (CBRN), you should immediately contact your local emergency response authorities (911). Additionally, for CBRN incidents occurring:

- within the United States, call the National Response Center at 1-800-424-8802
- within Canada, call CANUTEC at 613-996-6666 (1-888-226-8832)
- within Mexico, call CENACOM at 555128-0000 extensions 36428, 36422, 36469, 37807, 37810
- in other countries, consult page 392

The following is general guidance and does not serve as specialized incident response training. Do not enter the scene without appropriate training and equipment.

First responders can use the following information to make an initial assessment of a situation they suspect involves criminal or terrorist use of chemical agents, biological agents and/or radioactive materials (CBRN). To help with this, the following paragraphs have a list of observable indicators that a CB agent or radioactive material has been used or is present. This section ends with a Safe Stand-Off Distance Chart for various threats when improvised explosive devices (IEDs) are involved.

DIFFERENCES BETWEEN A CHEMICAL, BIOLOGICAL AND RADIOLOGICAL AGENT

Chemical and biological agents as well as radioactive materials can be dispersed in the air we breathe, the water we drink, or on surfaces we physically contact. Dispersion methods may be as simple as opening a container or using conventional (garden) spray devices, or as elaborate as detonating an improvised explosive device.

Chemical incidents are characterized by the rapid onset of medical symptoms (in minutes to hours) and easily observed signatures (colored residue, dead foliage, pungent odor, dead insects and animals).

Biological incidents are characterized by the onset of symptoms in hours to days. Typically, there will be no characteristic signatures because biological agents are usually odorless and colorless. Because of the delayed onset of symptoms, the affected area may be greater due to the movement of infected people.

Radiological incidents are characterized by the onset of symptoms, if any, in days to weeks or longer. Typically, there will be no characteristic signatures because radioactive materials are usually odorless and colorless. Specialized equipment is needed to determine the size of the affected area, and if the level of radioactivity is an immediate or long-term health hazard. Because it is impossible to detect radioactivity without special equipment, the affected area may be greater due to the migration of contaminated people.

The most probable sources would not generate enough radiation to kill people or cause severe illness. In a radiological incident generated by a "dirty bomb," or radiological dispersal device (RDD), in which a conventional explosive is detonated to spread radioactive contamination, the primary hazard is from the explosion. However, certain radioactive materials dispersed in the air could contaminate up to several city blocks, creating fear and possibly panic, and needing potentially costly cleanup.

INDICATORS OF A POSSIBLE CHEMICAL INCIDENT

Dead animals/birds/fish	Not just an occasional road kill, but numerous animals (wild and domestic, small and large), birds, and fish in the same area.
Lack of insect life	If normal insect activity (ground, air, and/or water) is missing, check the ground, water surface or shore line for dead insects. If near water, check for dead fish and/or aquatic birds.
Unexplained odors	Possible odors include fruity, flowery, sharp, pungent, garlic, horseradish-like, bitter almonds, peach kernels, or newly mown hay. The odor is completely out of character with its surroundings.
Unusual numbers of dying or sick people (mass casualties)	Health problems including nausea, disorientation, difficulty in breathing, convulsions, localized sweating, conjunctivitis (reddening of eyes), erythema (reddening of skin) and death.
Pattern of casualties	Casualties will likely be distributed downwind, or if indoors, by the air ventilation system.
Blisters or rashes	Numerous people experiencing unexplained water-like blisters, weals (like bee stings), and/or rashes.
Illness in confined area	Different casualty rates for people working indoors versus outdoors dependent on where the agent was released.
Unusual liquid droplets	Numerous surfaces show oily droplets or film; numerous water surfaces have an oily film (no recent rain).
Different-looking areas	Not just a patch of dead weeds, but trees, shrubs, bushes, food crops, and/or lawns that are dead, discolored, or withered (no current drought).
Low-lying clouds	Low-lying cloud or fog-like condition not consistent with its surroundings.
Unusual metal debris	Unexplained bomb or munitions-like material, especially if it contains a liquid.

INDICATORS OF A POSSIBLE BIOLOGICAL INCIDENT

Unusual numbers of sick or dying people or animals	Any number of symptoms may occur. Casualties may occur hours to days after an incident has occurred. The time required before symptoms are observed is dependent on the agent.
Unscheduled and unusual spray being disseminated	Especially if outdoors during periods of darkness.
Abandoned spray devices	Devices may not have distinct odors.

INDICATORS OF A POSSIBLE RADIOLOGICAL INCIDENT

Radiation Symbols	Containers may display a “propeller” radiation symbol.
Unusual metal debris	Unexplained bomb or munitions-like material.
Heat-emitting material	Material that is hot or seems to emit heat without any sign of an external heat source.
Glowing material	Strongly radioactive material may emit or cause radioluminescence.
Sick people/animals	In very improbable scenarios there may be unusual numbers of sick or dying people or animals. Casualties may occur hours to days or weeks after an incident has occurred. The time required before symptoms are observed is dependent on the radioactive material used, and the dose received. Possible symptoms include skin reddening or vomiting.

PERSONAL SAFETY CONSIDERATIONS

When you approach a scene that may involve CB agents or radioactive materials, the most critical thing to consider is your safety and that of other responders.

Use protective clothing and respiratory protection of an appropriate level of safety. In incidents where you suspect that CBRN materials have been used as weapons, NIOSH-certified respirators with CBRN protection are highly recommended. Be aware that you may not be able to verify or identify CB agents or radioactive materials, especially in the case of biological or radiological agents.

The following actions apply to a chemical, biological or radiological incident. This guidance is general. Responders will need to apply it on a case-by-case basis.

Approach and response strategies:

- Minimize exposure time.
- Maximize the distance between you and the item that is likely to harm you.
- Use cover as protection.

- Wear appropriate personal protective equipment and respiratory protection.
- Identify and estimate the hazard by using the indicators above.
- Isolate the area and secure the scene.
- Isolate and decontaminate potentially contaminated people as soon as possible.
- To the extent possible, take measures to limit the spread of contamination.

In the event of a **chemical** incident, the fading of chemical odors does not necessarily indicate reduced vapor concentrations. Some chemicals deaden the senses, giving you the false perception that the chemical is no longer present.

If there is any indication that an area may be contaminated with **radioactive** materials, including the site of any non-accidental explosion, responders:

- should be equipped with radiation detection equipment
- should have adequate training in how to use this equipment

This equipment should be designed to also alert responders when an unacceptable ambient dose rate or ambient dose has been reached.

Initial actions to consider in a potential CBRN/terrorism event:

- Avoid using cell phones, radios, etc. within 100 meters (300 feet) of a suspect device.
- Notify your local police by calling 911.
- Set up incident command upwind and uphill of the area.
- Do **not** touch or move suspicious packages or containers.
- Be cautious about the potential presence of secondary devices (e.g., improvised explosive devices (IEDs)).
- Avoid contamination.
- Limit access to only those responsible for rescue of victims or assessment of unknown materials or devices.
- Evacuate and isolate people who were potentially exposed to hazardous materials/ dangerous goods.
- Isolate contaminated areas and secure the scene for analysis of material.

DECONTAMINATION MEASURES

For chemical and biological agents: Emergency responders should follow standard decontamination procedures (flush-strip-flush). Mass casualty decontamination should begin as soon as possible by stripping all clothing, and flushing with soap and water. For further information, contact the agencies listed on the inside back cover of this guidebook.

For people contaminated with radioactive material: Take care to minimize the spread of the contamination to the extent possible. Move them to a low radiation area if necessary, and if it can be done safely. Remove their clothing and place it in a clearly marked and sealed receptacle, such as a plastic bag, for later testing. Use decontamination methods

described above, but avoid breaking the skin (e.g., vigorous brushing). External radiological contamination on intact skin rarely causes a high enough dose to be a hazard, to either the contaminated individual or the first responders. For this reason, prioritize medical stabilization for a contaminated injured individual.

NOTE: The above information was developed in part by the Department of National Defence (Canada), the U.S. Department of the Army, Aberdeen Proving Ground and the Federal Bureau of Investigation (FBI).

IMPROVISED EXPLOSIVE DEVICE (IED)

An IED is a "homemade" bomb and/or destructive device used to destroy, incapacitate, harass, or distract. Because they are improvised, IEDs can come in many forms, ranging from a small pipe bomb to a sophisticated device capable of causing massive damage and loss of life.

The following table predicts the damage radius based on the volume or weight of explosive (TNT equivalent) and the type of bomb.

Improvised Explosive Device (IED)
SAFE STAND-OFF DISTANCE

Threat Description		Explosives Capacity[1]		Mandatory Evacuation Distance[2]		Shelter-in-Place Zone		Preferred Evacuation Distance[3]	
High Explosives (TNT Equivalent)	Pipe Bomb	5 lbs	2.3 kg	70 ft	21 m	71 - 1,199 ft	22 - 365 m	+1,200 ft	366 m
	Suicide Bomber	20 lbs	9 kg	110 ft	34 m	111 - 1,699 ft	35 - 518 m	+1,700 ft	519 m
	Briefcase/Suitcase	50 lbs	23 kg	150 ft	46 m	151 - 1,849 ft	47 - 563 m	+1,850 ft	564 m
	Car	500 lbs	227 kg	320 ft	98 m	321 - 1,899 ft	99 - 579 m	+1,900 ft	580 m
	SUV/Van	1,000 lbs	454 kg	400 ft	122 m	401 - 2,399 ft	123 - 731 m	+2,400 ft	732 m
	Small Delivery Truck	4,000 lbs	1,814 kg	640 ft	195 m	641 - 3,799 ft	196 - 1,158 m	+3,800 ft	1,159 m
	Container/Water Truck	10,000 lbs	4,536 kg	860 ft	263 m	861 - 5,099 ft	264 - 1,554 m	+5,100 ft	1,555 m
	Semi-Trailer	60,000 lbs	27,216 kg	1,570 ft	475 m	1,571 - 9,299 ft	476 - 2,834 m	+9,300 ft	2,835 m

[1] Based on the maximum amount of material that could reasonably fit into a container or vehicle. Variations possible.

[2] Governed by the ability of an unreinforced building to withstand severe damage or collapse.

[3] Governed by the greater of fragment throw distance or glass breakage/falling glass hazard distance. These distances can be reduced for personnel wearing ballistic protection. Note that the pipe bomb, suicide bomb, and briefcase/suitcase bomb are assumed to have a fragmentation characteristic that requires greater stand-off distances than an equal amount of explosives in a vehicle.

Improvised Explosive Device (IED)
SAFE STAND-OFF DISTANCE

Threat Description		LPG Mass / Volume[1]		Fireball Diameter[2]		Safe Distance[3, 4]	
LPG - Butane or Propane	Small LPG Tank	20 lbs / 5 gal	9 kg / 19 L	40 ft	12 m	160 ft	48 m
	Large LPG Tank	100 lbs / 25 gal	45 kg / 95 L	69 ft	21 m	276 ft	84 m
	Commercial/Residential LPG Tank	2,000 lbs / 500 gal	907 kg / 1,893 L	184 ft	56 m	736 ft	224 m
	Small LPG Truck	8,000 lbs / 2,000 gal	3,630 kg / 7,570 L	292 ft	89 m	1,168 ft	356 m
	Semitanker LPG	40,000 lbs / 10,000 gal	18,144 kg / 37,850 L	499 ft	152 m	1,996 ft	608 m

[1] Based on the maximum amount of LPG that could reasonably fit into a container or vehicle. Variations possible.

[2] Assuming efficient mixing of the flammable gas with ambient air.

[3] Determined by U.S. firefighting practices wherein safe distances are approximately 4 times the flame height.

[4] This table is for a loaded LPG tank with explosives on the exterior. Note that an LPG tank filled with high explosives would require a significantly greater stand-off distance than if it were filled with LPG.

GLOSSARY

Adsorbed gas — A gas which sticks (adsorbs) to the surface of a solid and porous material (such as activated charcoal) contained within a metal cylinder. This results in an internal cylinder pressure of less than 101.3 kPa at 20°C (14 psi at 68°F) and less than 300 kPa at 50°C (43 psi at 122°F). These pressures are much lower than those of conventional cylinders containing compressed or liquefied gases.

AEGL(s) — Acute Exposure Guideline Level(s), AEGLs represent threshold exposure limits for the general public after a once-in-a-lifetime, or rare, exposure and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. Three levels AEGL-1, AEGL-2 and AEGL-3 are developed for each of five exposure periods (10 and 30 minutes, 1 hour, 4 hours, and 8 hours) and are distinguished by varying degrees of severity of toxic effects; see AEGL-1, AEGL-2 and AEGL-3.

AEGL-1 — AEGL-1 is the airborne concentration (expressed as parts per million or milligrams per cubic meter [ppm or mg/m^3]) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 — AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) 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 — AEGL-3 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

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

Biological agents — Pathogens (bacteria, viruses, etc.) or the toxins they produce (such as anthrax) that are dispersed with criminal intent. They can cause disease or death in otherwise healthy humans. **Refer to GUIDE 158**.

BLEVE — Boiling Liquid Expanding Vapor Explosion

GLOSSARY

Blister agents (vesicants)	Substances that cause blistering of the skin. Exposure is through liquid or vapor contact with any exposed tissue (eyes, skin, lungs). Mustard (H), Distilled Mustard (HD), Nitrogen Mustard (HN) and Lewisite (L) are blister agents. **Symptoms:** Red eyes, skin irritation, burning of skin, blisters, upper respiratory damage, cough, hoarseness.
Blood agents	Substances that injure a person by interfering with cell respiration (the exchange of oxygen and carbon dioxide between blood and tissues). Hydrogen cyanide (AC) and Cyanogen chloride (CK) are blood agents. **Symptoms:** Respiratory distress, headache, unresponsiveness, seizures, coma.
Boil over	A sudden increase in fire intensity associated with the expulsion of burning flammable liquid caused by the boiling of water that has accumulated in the bottom of a tank car.
Burn	Refers to either a chemical or thermal burn, the former may be caused by corrosive substances and the latter by liquefied cryogenic gases, hot molten substances, or flames.
Carcinogen	A substance or mixture which induces cancer or increases its incidence.
Category A	An infectious substance that poses a high risk to the health of individuals and/or animals or public health. These substances can cause serious disease and can lead to death. Effective treatment and preventative measures may not be available.
Category B	An infectious substance that poses a low to moderate risk to individuals and/or animals and/or public health. These substances are unlikely to cause serious disease. Effective treatment and preventative measures are available.
CBRN	Chemical, biological, radiological or nuclear agent.
Choking agents	Substances that cause physical injury to the lungs. Exposure is through inhalation. In extreme cases, membranes swell and lungs become filled with liquid (pulmonary edema). Death results from lack of oxygen; hence, the victim is "choked". Phosgene (CG) is a choking agent. **Symptoms:** Irritation to eyes/nose/throat, respiratory distress, nausea and vomiting, burning of exposed skin.
CO_2	Carbon dioxide gas.

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

Combustible liquid Liquids which have a flash point greater than 60°C (140°F) and below 93°C (200°F). U.S. regulations permit a flammable liquid with a flash point between 38°C (100°F) and 60°C (140°F) to be reclassed as a combustible liquid.

Compatibility Group Letters identify explosives that are deemed to be compatible. The definition of these Compatibility Groups in this Glossary are intended to be descriptive. Please consult the transportation of hazardous materials/dangerous goods or explosives regulations of your jurisdiction for the exact wording of the definitions. Class 1 materials are considered to be "compatible" if they can be transported together without significantly increasing either the probability of an incident or, for a given quantity, the magnitude of the effects of such an incident.

- A Substances which are expected to mass detonate very soon after fire reaches them.
- B Articles which are expected to mass detonate very soon after fire reaches them.
- C Substances or articles which may be readily ignited and burn violently without necessarily exploding.
- D Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire.
- E & F Articles which may mass detonate in a fire.
- G Substances and articles which may mass explode and give off smoke or toxic gases.
- H Articles which in a fire may eject hazardous projectiles and dense white smoke.
- J Articles which may mass explode.
- K Articles which in a fire may eject hazardous projectiles and toxic gases.
- L Substances and articles which present a special risk and could be activated by exposure to air or water.

GLOSSARY

Compatibility Group (continued)

N Articles which contain only extremely insensitive detonating substances and demonstrate a negligible probability of accidental ignition or propagation.

S Packaged substances or articles which, if accidentally initiated, produce effects that are usually confined to the immediate vicinity.

Control zones Designated areas at hazardous materials/dangerous goods incidents, based on safety and the degree of hazard. Many terms are used to describe control zones; however, in this guidebook, these zones are defined as the hot/exclusion/red/restricted zone, warm/contamination reduction/yellow/limited access zone, and cold/support/green/clean zone. (EPA Standard Operating Safety Guidelines, OSHA 29 CFR 1910.120, NFPA 472).

Cryogenic liquid A refrigerated, liquefied gas that has a boiling point colder than -90°C (-130°F) at atmospheric pressure or is handled or transported at a temperature equal to or less than -100°C (-148°F).

Decomposition products Products of a chemical or thermal break-down of a substance.

Decontamination The removal of hazardous materials/dangerous goods from personnel and equipment to the extent necessary to prevent potential adverse health effects. See "Decontamination", page 362.

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

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

ERPG(s) Emergency Response Planning Guideline(s). Values intended to provide estimates of concentration ranges above which one could reasonably anticipate observing adverse health effects; see ERPG-1, ERPG-2 and ERPG-3.

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

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ERPG-2 — The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

ERPG-3 — The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Flammable liquid — A liquid that has a flash point of 60°C (140°F) or lower.

Flash point — Lowest temperature at which a liquid or solid gives off vapor in such a concentration that, when the vapor combines with air near the surface of the liquid or solid, a flammable mixture is formed. Hence, the lower the flash point, the more flammable the material.

Flooding quantities — Minimum of 1900 L/min (500 US gal/min) of water.

Hazard zones (Inhalation Hazard Zones)

HAZARD ZONE A: Gases: LC50 of less than or equal to 200 ppm, Liquids: V equal to or greater than 500 LC50 and LC50 less than or equal to 200 ppm.

HAZARD ZONE B: Gases: LC50 greater than 200 ppm and less than or equal to 1000 ppm, Liquids: V equal to or greater than 10 LC50; LC50 less than or equal to 1000 ppm and criteria for Hazard Zone A are not met.

HAZARD ZONE C: LC50 greater than 1000 ppm and less than or equal to 3000 ppm.

HAZARD ZONE D: LC50 greater than 3000 ppm and less than or equal to 5000 ppm.

Please note: even though the term "zone" is used, hazard zones are not an actual area or distance. How zones are assigned is strictly a function of the lethal concentration 50 (LC50) of the product. For example, TIH Zone A is more toxic than Zone D.

High expansion foam — Foams that have a high expansion ratio (over 1:200) with a low water content.

Hot zone — Area immediately surrounding a hazardous materials/dangerous goods incident which extends far enough to prevent adverse effects from the released product to personnel outside the zone. This zone is also referred to as exclusion zone, red zone or restricted zone in other documents. (EPA Standard Operating Safety Guidelines, OSHA 29 CFR 1910.120, NFPA 472).

IED — See "Improvised Explosive Device".

GLOSSARY

Immiscible — In this guidebook, means that a material does not mix readily with water.

Improvised Explosive Device — A bomb that is manufactured from commercial, military or homemade explosives.

Large spill — A spill that involves quantities that are greater than 208 liters (55 US gallons). This usually involves a spill from a large package, or multiple spills from many small packages.

LC50 — Lethal concentration 50. The concentration of a material administered by inhalation that is expected to cause the death of 50% of an experimental animal population within a specified time. (Concentration is reported in either ppm or mg/m^3).

Mass explosion — Explosion which affects almost the entire load virtually instantaneously.

MAWP — Maximum Allowable Working Pressure: The maximum allowable internal pressure that the tank may experience during normal operations.

mg/m^3 — Milligrams of a material per cubic meter of air.

Miscible — In this guidebook, means that a material mixes readily with water.

mL/m^3 — Milliliters of a material per cubic meter of air. (1 mL/m^3 equals 1 ppm).

Mutagen — An agent giving rise to an increased occurrence of mutations in populations of cells and/or organisms. Mutation means a permanent change in the amount or structure of the genetic material in a cell.

Narcotic — A substance which acts as a central nervous system depressor producing effects such as drowsiness, narcosis, reduced alertness, loss of reflexes, lack of coordination, and vertigo. These effects can also be manifested as severe headache or nausea, and can lead to reduced judgment, dizziness, irritability, fatigue, impaired memory function, deficit in perception and coordination, reaction time, or sleepiness.

Nerve agents — Substances that interfere with the central nervous system. Exposure is primarily through contact with the liquid (via skin and eyes) and secondarily through inhalation of the vapor. Tabun (GA), Sarin (GB), Soman (GD) and VX are nerve agents.

Symptoms: Pinpoint pupils, extreme headache, severe tightness in the chest, dyspnea, runny nose, coughing, salivation, unresponsiveness, seizures.

n.o.s. These letters refer to "not otherwise specified". The entries which use this description are generic names such as "Corrosive liquid, n.o.s." This means that the actual chemical name for that corrosive liquid is not listed in the regulations; therefore, a generic name must be used to describe it on shipping papers.

Noxious In this guidebook, means that a material may be harmful or injurious to health or physical well-being.

Organic Peroxide An organic (carbon-containing) compound having two oxygen atoms joined together. Organic peroxides are thermally unstable chemicals. They may have one or more of the following properties: be liable to explosive decomposition; burn rapidly; be sensitive to impact or friction; react dangerously with other substances.

Oxidizer A chemical which supplies its own oxygen and which helps other combustible material burn more readily.

P See "Polymerization".

Packing Group The Packing Group (PG) is assigned based on the degree of danger presented by the hazardous material/dangerous good:

PG I : Great danger
PG II : Medium danger
PG III : Minor danger

PG See "Packing Group".

pH pH is a value that represents the acidity or alkalinity of a water solution. Pure water has a pH of 7. A pH value below 7 indicates an acid solution (a pH of 1 is extremely acidic). A pH above 7 indicates an alkaline solution (a pH of 14 is extremely alkaline). Acids and alkalies (bases) are commonly referred to as corrosive materials.

PIH Poison Inhalation Hazard. See "TIH".

Polar See "Miscible".

Polymerization A chemical reaction that often produces heat and pressure. Once initiated, the reaction is accelerated by the heat that it produces. The uncontrolled buildup of heat and pressure can cause a fire or an explosion, or can rupture closed containers. The letter (**P**) following a guide number in the yellow-bordered and blue-bordered pages identifies a material that may polymerize violently under high temperature conditions or contamination with other products during a transportation incident. It is also used to identify materials that have a strong potential for polymerization in the absence of an inhibitor due to depletion of this inhibitor caused by accident conditions.

ppm Parts per million. (1 ppm equals 1 mL/m^3).

Protective clothing In this guidebook, protective clothing includes both respiratory and physical protection. One cannot assign a level of protection to clothing or respiratory devices separately. These levels were accepted and defined by response organizations such as U.S. Coast Guard, NIOSH, and U.S. EPA.

Level A: SCBA plus totally encapsulating chemical resistant clothing (permeation resistant).

Level B: SCBA plus hooded chemical resistant clothing (splash suit).

Level C: Full or half-face respirator plus hooded chemical resistant clothing (splash suit).

Level D: Coverall, including structural firefighters' protective clothing (SFPC), with no respiratory protection.

SCBA: Self-contained breathing apparatus.

Consult "Protective Clothing", pages 360-361

Pyrophoric A material which ignites spontaneously upon exposure to air (or oxygen).

Radiation Authority As referred to in GUIDES 161 through 166 for radioactive materials, the Radiation Authority is either a Federal, state/provincial agency or state/province designated official. The responsibilities of this authority include evaluating radiological hazard conditions during normal operations and during emergencies. If the identity and telephone number of the authority are not known by emergency responders, or included in the local response plan, the information can be obtained from the agencies listed on the inside back cover. They maintain a periodically updated list of radiation authorities.

Radioactivity The property of some substances to emit invisible and potentially harmful radiation.

Refrigerated liquid See "Refrigerated liquefied gas".

Refrigerated liquefied gas A gas which when packaged for transport is made partially liquid because of its low temperature. See "Cryogenic liquid".

Respiratory sensitizer A substance that induces hypersensitivity of the airways following inhalation of the substance.

Right-of-way A defined area on a property containing one or more high-pressure natural gas pipelines.

Shelter-in-place People should seek shelter inside a building and remain inside until the danger passes. **Sheltering-in-place is used when evacuating the public would cause greater risk than staying where they are, or when an evacuation cannot be performed.** Direct the people inside to **close all doors and windows** and to **shut off all ventilating, heating and cooling systems.** In-place protection (shelter-in-place) may not be the best option if (a) the vapors are flammable; (b) if it will take a long time for the gas to clear the area; or (c) if buildings cannot be closed tightly. Vehicles can offer some protection for a short period if the windows are closed and the ventilating systems are shut off. Vehicles are not as effective as buildings for in-place protection.

Skin corrosion The production of irreversible damage to the skin following the application of a test substance for up to 4 hours.

Skin irritation The production of reversible damage to the skin following the application of a test substance for up to 4 hours.

Skin sensitizer A substance that will induce an allergic response following skin contact.

Small spill A spill that involves quantities that are 208 liters (55 US gallons) or less. This generally corresponds to a spill from a single small package (for example, a drum), a small cylinder, or a small leak from a large package.

Specific gravity Weight of a substance compared to the weight of an equal volume of water at a given temperature. Specific gravity less than 1 indicates a substance is lighter than water; specific gravity greater than 1 indicates a substance is heavier than water.

Straight (solid) stream Method used to apply or distribute water from the end of a hose. The water is delivered under pressure for penetration. In an efficient straight (solid) stream, approximately 90% of the water passes through an imaginary circle 38 cm (15 inches) in diameter at the breaking point. Hose (solid or straight) streams are frequently used to cool tanks and other equipment exposed to flammable liquid fires, or for washing burning spills away from danger points. However, straight streams will cause a spill fire to spread if improperly used or when directed into open containers of flammable and combustible liquids.

TIH Toxic Inhalation Hazard. Term used to describe gases and volatile liquids that are toxic when inhaled (same as PIH). These materials pose a known hazard to human health during transport or is presumed to be toxic to humans because of animal-based studies.

V	Saturated vapor concentration in air of a material in mL/m^3 (ppm) at 20°C and standard atmospheric pressure.
Vapor density	Weight of a volume of pure vapor or gas (with no air present) compared to the weight of an equal volume of dry air at the same temperature and pressure. A vapor density less than 1 (one) indicates that the vapor is lighter than air and will tend to rise. A vapor density greater than 1 (one) indicates that the vapor is heavier than air and may travel along the ground
Vapor pressure	Pressure at which a liquid and its vapor are in equilibrium at a given temperature. Liquids with high vapor pressures evaporate rapidly.
Viscosity	Measure of a liquid's internal resistance to flow. This property is important because it indicates how fast a material will leak out through holes in containers or tanks.
Warm zone	Area between Hot and Cold zones where personnel and equipment decontamination and hot zone support take place. It includes control points for the access corridor and thus assists in reducing the spread of contamination. Also referred to as the contamination reduction corridor (CRC), contamination reduction zone (CRZ), yellow zone or limited access zone in other documents. (EPA Standard Operating Safety Guidelines, OSHA 29 CFR 1910.120, NFPA 472).
Water Reactive Material	In this guidebook, materials which produce significant toxic gas when it comes in contact with water.
Water-sensitive	Substances which may produce flammable and/or toxic decomposition products upon contact with water.

Water spray (fog)

Method or way to apply or distribute water. The water is finely divided to provide for high heat absorption. Water spray patterns can range from about 10 to 90 degrees. Water spray streams can be used to extinguish or control the burning of a fire or to provide exposure protection for personnel, equipment, buildings, etc. **(This method can be used to absorb vapors, knock-down vapors or disperse vapors. Direct a water spray (fog), rather than a straight (solid) stream, into the vapor cloud to accomplish any of the above).**

Water spray is particularly effective on fires of flammable liquids and volatile solids having flash points above 37.8°C (100°F).

Regardless of the above, water spray can be used successfully on flammable liquids with low flash points. The effectiveness depends particularly on the method of application. With proper nozzles, even gasoline spill fires of some types have been extinguished when coordinated hose lines were used to sweep the flames off the surface of the liquid. Furthermore, water spray carefully applied has frequently been used with success in extinguishing fires involving flammable liquids with high flash points (or any viscous liquids) by causing frothing to occur only on the surface, and this foaming action blankets and extinguishes the fire.

PUBLICATION DATA

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ERG2020 is based on earlier Transport Canada, U.S. DOT, and Secretariat of Communications and Transport emergency response guidebooks. ERG2020 is published in three languages: English, French and Spanish. The Emergency Response Guidebook has been translated and printed in other languages, including Chinese, German, Hebrew, Japanese, Portuguese, Korean, Hungarian, Polish, Turkish and Thai.

We encourage countries that wish to translate this Guidebook to please contact any of the websites or telephone numbers in the next paragraph.

DISTRIBUTION OF THIS GUIDEBOOK

The primary objective is to place one copy of the ERG2020 in each publicly owned emergency service vehicle through distribution to Federal, state, provincial and local public safety authorities. The distribution of this guidebook is being accomplished through the voluntary cooperation of a network of key agencies. Emergency service organizations that have not yet received copies of ERG2020 should contact the respective distribution center in their country, state or province. In the U.S., information about the distribution center for your location may be obtained from the Office of Hazardous Materials Safety website at https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg or call 202-366-4900. In Canada, contact CANUTEC at 613-992-4624 or via the website at https://www.tc.gc.ca/canutec for information. In Mexico, call SCT at +52 55-57-23-93-00 ext. 20010 or 20577, or via email at cserrano@sct.gob.mx. In Argentina, call CIQUIME at +54-11-5199-1409, or via the website at http://www.ciquime.org or via email at gre@ciquime.org.

REPRODUCTION AND RESALE

Copies of this document which are provided free-of-charge to fire, police and other emergency services may not be resold. ERG2020 (PHH50-ERG2020) may be reproduced without further permission subject to the following:

The names and the seals of the participating governments may not be reproduced on a copy of this document unless that copy accurately reproduces the entire content (text, format, and coloration) of this document without modification. In addition, the publisher's full name and address must be displayed on the outside back cover of each copy, replacing the wording placed on the center of the back cover.

Constructive comments concerning ERG2020 are solicited; in particular, comments concerning its use in handling incidents involving hazardous materials/dangerous goods. Comments should be addressed to:

In Canada:

Director, CANUTEC
Transport Dangerous Goods
Transport Canada
Ottawa, Ontario
Canada K1A 0N5

Phone: 613-992-4624 (information)
Fax: 613-954-5101
Email: canutec@tc.gc.ca

In the U.S.:

U. S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Outreach, Engagement, and Grants Division (PHH-50)
Washington, DC 20590-0001

Phone: 202-366-4900
Fax: 202-366-7342
Email: ERGComments@dot.gov

In Mexico:

Secretaría de Comunicaciones y Transportes
Dirección General de Autotransporte Federal
Dirección General Adjunta de Normas y Especificaciones
Técnicas y de Seguridad en el Autotransporte
Calzada de las Bombas No. 411-2 piso,
Col. Los Girasoles,
Alcaldía de Coyoacán,
Código Postal 04920,
Ciudad de México
Phone: +52 55-57-23-93-00 ext. 20010 or 20577
Email: cserrano@sct.gob.mx

In Argentina:

Centro de Información Química para Emergencias (CIQUIME)
Av. Alvarez Thomas 636
C1427CCT Buenos Aires, Argentina
Phone: +54-11-5199-1409
Email: gre@ciquime.org

The Emergency Response Guidebook is normally revised and reissued every four years. However, in the event of a significant mistake, omission or change in the state of knowledge, special instructions to change the guidebook (in pen-and-ink, with paste-over stickers, or with a supplement) may be issued.

Users of this guidebook should check periodically (about every 6 months) to make sure their version is current. Changes should be annotated below. Contact:

DOT/PHMSA
https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg

TRANSPORT CANADA
https://www.tc.gc.ca/eng/canutec/menu.htm

CIQUIME
http://www.ciquime.org

This guidebook incorporates changes dated:

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CANADA AND UNITED STATES NATIONAL RESPONSE CENTERS

For the purposes of this guidebook, the terms hazardous materials/dangerous goods are synonymous.

CANADA

1. **CANUTEC**

CANUTEC is the **Canadian Transport Emergency Centre** operated by the Transportation of Dangerous Goods Directorate of Transport Canada.
CANUTEC provides a national bilingual (French and English) advisory service and is staffed by professional scientists experienced and trained in interpreting technical information and providing emergency response advice.

In an emergency, CANUTEC may be called at 1-888-CANUTEC (226-8832)
or collect at 613-996-6666 (24 hours)
***666 cellular (Press Star 666, Canada only)**

In a non-emergency situation, please call the information line at 613-992-4624 (24 hours).

2. PROVINCIAL/TERRITORIAL AGENCIES

Although technical information and emergency response assistance can be obtained from **CANUTEC**, there are federal, provincial and territorial regulations requiring the reporting of dangerous goods incidents to certain authorities.

The following list of provincial/territorial agencies is supplied for your convenience.

Province	Emergency Authority and/or Telephone Number
Alberta	Local Police and Provincial Authorities 1-800-272-9600 or 780-422-9600
British Columbia	Local Police and Provincial Authorities 1-800-663-3456
Manitoba	Provincial Authority 204-945-4888 and Local Police or fire brigade, as appropriate
New Brunswick	Local Police or 1-800-565-1633
Newfoundland and Labrador	Local Police and 709-772-2083
Northwest Territories	867-920-8130
Nova Scotia	Local Police or 1-800-565-1633
Nunavut	Local Police and 867-920-8130
Ontario	Local Police
Prince Edward Island	Local Police or 1-800-565-1633
Quebec	Local Police
Saskatchewan	Local Police or 1-800-667-7525
Yukon Territory	867-667-7244

NOTE:

1. The appropriate federal agency must be notified in the case of rail, air or marine incidents.
2. The nearest police department must be notified in the case of lost, stolen or misplaced explosives, radioactive materials or infectious substances.
3. **CANUTEC must** be notified in the case of:
   a. lost, stolen or unlawfully interfered with dangerous goods (except Class 9)
   b. an incident involving infectious substances
   c. an accidental release from a cylinder that has suffered a catastrophic failure
   d. an incident where the shipping papers display **CANUTEC**'s telephone number 1-888-CANUTEC (226-8832) or 613-996-6666 as the emergency telephone number or
   e. a dangerous goods incident in which a railway vehicle, a ship, an aircraft, an aerodrome or an air cargo facility is involved

3. EMERGENCY RESPONSE ASSISTANCE PLANS (Applies in Canada ONLY)

An ERAP or Emergency Response Assistance Plan is an approved plan that describes what is to be done in the event of a transportation accident involving certain higher risk dangerous goods. The ERAP is required by the Canadian *Transportation of Dangerous Goods Act* for dangerous goods that require special expertise and response equipment to respond to an incident. The plan is intended to assist local emergency responders by providing them with technical experts and specially trained and equipped emergency response personnel at the scene of a dangerous goods incident.

The ERAP will describe the specialized response capabilities, equipment and procedures that will be used to support a response to incidents involving high risk dangerous goods. The plan will also address emergency preparedness, including personnel training, response exercises and equipment maintenance. The ERAP plans supplement those of the carrier and of the local and provincial authorities, and must be integrated with other organizations to help mitigate the consequences of an accident.

For shipments that require an ERAP, the ERAP number and the phone number to activate the ERAP will be included on the shipping paper. If additional information is required, or to determine if the product involved in the emergency requires an ERAP, contact **CANUTEC**.

CANUTEC may be called at 1-888-CANUTEC (226-8832)
or collect at 613-996-6666 (24 hours)
666 on cellular phone (Press star 666) *In Canada Only

NATIONAL RESPONSE CENTER (NRC)

The NRC, which is operated by the U.S. Coast Guard, receives reports required when hazardous materials are spilled. After receiving notification of an incident, the NRC will immediately notify the appropriate Federal On-Scene Coordinator and concerned Federal agencies. Federal law requires that anyone who releases into the environment a reportable quantity of a hazardous material (including oil when water is, or may be affected) or a material identified as a marine pollutant, must **immediately** notify the NRC. When in doubt as to whether the amount released equals the required reporting levels for these materials, the NRC should be notified.

CALL **NRC** (24 hours)

1-800-424-8802

(Toll-free in the U.S., Canada, and the U.S. Virgin Islands)

202-267-2675 in the District of Columbia

Calling the emergency response telephone number, CHEMTREC®, CHEMTEL, INC., INFOTRAC or 3E COMPANY, does not constitute compliance with regulatory requirements to call the NRC.

24-HOUR EMERGENCY RESPONSE TELEPHONE NUMBERS

MEXICO

1. CENACOM

555128-0000 extensions 36428, 36422, 36469, 37807, 37810

2. CONASENUSA

800-11-131-68 in the Republic of Mexico

3. SETIQ

800-00-21-400 or **55-5559-1588**
For calls originating elsewhere, call: **+52-55-5559-1588**

ARGENTINA

1. CIQUIME

0-800-222-2933 in the Republic of Argentina
For calls originating elsewhere, call: **+54-11-4552-8747***

BRAZIL

1. PRÓ-QUÍMICA

0-800-118270 in Brazil
For calls originating elsewhere, call: **+55-19-3833-5310***

COLOMBIA

1. CISPROQUIM

01-800-091-6012 in Colombia
For calls originating in Bogotá, Colombia call: **288-6012**
For calls originating elsewhere call: **+57-1-288-6012**

CHILE

1. CITUC QUÍMICO

2-2247-3600 in the Republic of Chile
For calls originating elsewhere call **+56-2-2247-3600**

* Collect calls are accepted

24-HOUR EMERGENCY RESPONSE TELEPHONE NUMBERS

CANADA

1. CANUTEC

1-888-CANUTEC (226-8832) or **613-996-6666 ***
***666 (STAR 666) cellular** (in Canada only)

UNITED STATES

1. CHEMTREC

1-800-424-9300
(in the U.S., Canada and the U.S. Virgin Islands)
For calls originating elsewhere: **703-527-3887 ***

2. CHEMTEL, INC.

1-888-255-3924
(in the U.S., Canada, Puerto Rico and the U.S. Virgin Islands)
For calls originating elsewhere: **813-248-0573 ***

3. INFOTRAC

1-800-535-5053
(in the U.S., Canada and the U.S. Virgin Islands)
For calls originating elsewhere: **352-323-3500 ***

4. VERISK 3E

1-800-451-8346
(in the U.S., Canada and the U.S. Virgin Islands)
For calls originating elsewhere: **760-602-8703 ***

The emergency response information services shown above maintain periodically updated lists of state and Federal radiation authorities who provide information and technical assistance on handling incidents involving radioactive materials.

5. MILITARY SHIPMENTS, for assistance at incidents involving materials being shipped by, for, or to the Department of Defense (DOD), call one of the following numbers:

703-697-0218 * - Explosives/ammunition incidents
(U.S. Army Operations Center)
1-800-851-8061 - All other hazardous materials/dangerous goods incidents
(Defense Logistics Agency)

6. NATIONWIDE POISON CONTROL CENTER (United States only)
1-800-222-1222

* Collect calls are accepted.