HOW TO USE TABLE 1 – INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

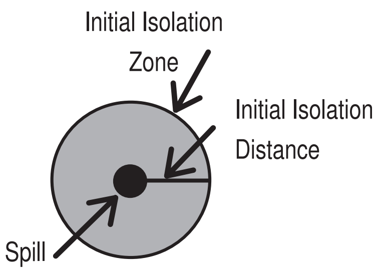
(1) The responder should already have:

- identified the material by its ID number and name (if you cannot find an ID number, use the Name of Material index in the blue section to find that number);
- confirmed that the material is highlighted in green in the yellow or blue section. If not, Table 1 doesn't apply;
- found the three-digit guide for the material, in order to consult emergency actions it recommends along with this table; and
- **noted the wind direction**

(2) Look in Table 1 (green section) for the ID number and name of the material involved. Some ID numbers have more than one shipping name listed. Look for the specific name of the material. If you do not know the shipping name and Table 1 lists more than one name for the same ID number, use the entry with the largest distances.

(3) Determine if the incident involves a SMALL or LARGE spill and if it is DAY or NIGHT. A SMALL SPILL consists of a release of 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. A LARGE SPILL consists of a release of more than 208 liters (55 US gallons). This usually involves a spill from a large package, or multiple spills from many small packages. DAY is any time after sunrise and before sunset. NIGHT is any time between sunset and sunrise.

(4) Look up the INITIAL ISOLATION DISTANCE. This distance defines the radius of a zone (initial isolation zone) surrounding the spill in ALL DIRECTIONS. In this zone, protective clothing and respiratory protection is required. Evacuate the general public in a direction perpendicular to wind direction (crosswind) and away from the spill.

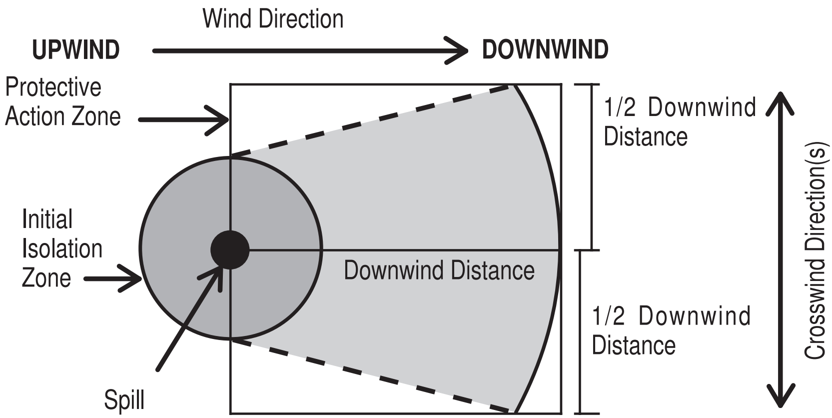


(5) Look up the PROTECTIVE ACTION DISTANCE.
For a given material, spill size, and whether day or night, Table 1 gives the downwind distance—in kilometers and miles—from the spill or leak source, for which you should consider protective actions. For practical purposes, the protective action zone (i.e., the area in which people are at risk of harmful exposure) is a square. Its length and width are the same as the downwind distance shown in Table 1. Protective actions are the steps you take to preserve the health and safety of emergency responders and

the public. **People in this area should be evacuated and/or sheltered-in-place**. For more information, consult the "Protective Actions" section.

(6) Initiate protective actions beginning with those closest to the spill site and working away in a downwind direction. When a water-reactive TIH (PIH in the US) producing material is spilled into a river or stream, the source of the toxic gas may move with the current or stretch from the spill point downstream for a large distance.

In the figure below, the spill is located at the center of the small black circle. The larger circle represents the initial isolation zone around the spill. The square (the protective action zone) is the area in which you should take protective actions.



Note 1: For factors that may change the protective action distances, see the "Introduction to Green Tables" section.

Note 2: When a product in Table 1 has the mention (when spilled in water), you can refer to Table 2 for the list of gases produced when these materials are spilled in water. The TIH gases indicated in Table 2 are for information purposes only.

Note 3: For the instantaneous release of the entire contents of a package (e.g., as a result of terrorism, sabotage or catastrophic failure), the distances should be doubled.

For more information on the material, safety precautions and mitigation procedures, call the emergency response telephone number listed on the shipping paper or the appropriate response agency as soon as possible.

INTRODUCTION TO GREEN TABLES

TABLE 1 - INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

This table suggests distances useful to protect people from vapors/gases resulting from spills involving:

- materials that are considered toxic by inhalation (TIH) (PIH in the US)
- materials which produce toxic gases upon contact with water

This table provides first responders with initial guidance until technically qualified emergency response personnel are available. For each material, first responders will find distances for the following zones:

- The **Initial Isolation Zone** defines an area **surrounding** the incident in which people may be exposed to dangerous (upwind) and life-threatening (downwind) concentrations of material.
- The **Protective Action Zone** defines an area **downwind** from the incident in which people may become incapacitated and unable to take protective action and/or incur serious or irreversible health effects. Table 1 provides specific guidance for small and large spills occurring day or night.

Adjusting distances for a specific incident involves many interdependent variables. These adjustments should only be made by technically qualified personnel. For this reason, no precise guidance can be provided in this document to aid in adjusting the table distances; however, general guidance follows.

Factors that May Change the Protective Action Distances

Fire

In the **orange section**, under **EVACUATION – Fire**, the evacuation distance required to protect against fragmentation hazard of a large container is clearly indicated. If involved in a fire, the toxic hazard may be less dangerous than the fire or explosion hazard.

In these cases, the **fire hazard distance should be used** as an isolation distance and Table 1 should be used to protect downwind for residual material release.

Worst-case scenario: terrorism, sabotage or catastrophic accident

Initial isolation and protective action distances are derived from historical data on transportation incidents and the use of statistical models. For worst-case scenarios involving the instantaneous release of the entire contents of a package (e.g., as a result of terrorism, sabotage or catastrophic accident), the distances may increase substantially.

For such events, **doubling** the initial isolation and protective action distances is appropriate in absence of other information.

When more than one large package is leaking

If more than one rail tank car, highway tank, tank or large cylinder, containing TIH materials is leaking, **large spill** distances may need to be increased.

Other factors that can increase the protective action distance:

- If a material has a **protective action distance of 11.0+ km (7.0+ miles)**, the actual distance can be larger in certain atmospheric conditions.
- If the material's vapor plume is **channeled in a valley** or **between many tall buildings**, protective action distances may be larger than shown due to less mixing of the plume with the atmosphere.
- If there is a **daytime spill** in a region with known **strong temperature inversions** or **snow cover**, or it occurs **near sunset**, this may require an increase of the protective action distance because airborne contaminants mix and disperse more slowly and may travel much farther downwind.
  - In such cases, the nighttime protective action distances may be more appropriate.
- If the temperature of the **liquid spill** or the **outdoor temperature exceeds 30°C (86°F)**, the protective action distance may be larger.

Water-reactive materials

Materials that react with water to produce large amounts of toxic gases are included in Table 1. Some of these 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.

Choose the **larger protective action distance** if:

- it is not clear whether the spill is on land or in water
- the spill occurs both on land and in water

TABLE 2 - WATER-REACTIVE MATERIALS WHICH PRODUCE TOXIC GASES

This table lists materials which produce large amounts of Toxic Inhalation Hazard gases (TIH) when spilled in water as well as the TIH gases that are produced.

NOTE: The produced TIH gases indicated in Table 2 are for information purposes only. In Table 1, the initial isolation and protective action distances have already taken into consideration the produced TIH gas.

When a water-reactive TIH-producing material is spilled into a river or stream, the source of the toxic gas may flow downstream for a great distance.

TABLE 3 - INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES FOR LARGE SPILLS FOR DIFFERENT QUANTITIES OF SIX COMMON TIH (PIH IN THE US) GASES

This table lists materials that may be more commonly encountered. These materials are:

- 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

This table provides initial isolation and protective action distances for large spills (more than 208 liters or 55 US gallons):

- involving different container types (therefore different volume capacities)
- for daytime and nighttime situations
- for different wind speeds (low, moderate and high)

PROTECTIVE ACTIONS

Protective actions are the steps taken to preserve the health and safety of emergency responders and the public during an incident involving releases of hazardous materials/ dangerous goods.

Table 1 - Initial Isolation and Protective Action Distances (green section) predicts the size of the area that could be affected by a cloud of toxic gas. People in this area should be evacuated and/or sheltered-in-place inside buildings.

Isolate hazard area and deny entry means to keep everybody away from the area if they are not directly involved in emergency response operations. Unprotected emergency responders should not be allowed to enter the isolation zone.

This "isolation" task is done to establish control over the area of operations. This is the first step for any protective actions that may follow.

Evacuate means to move all people from a threatened area to a safer place. To perform an evacuation, there must be enough time for people to be warned, get ready, and leave an area. If there is enough time, evacuation is the best protective action.

Begin evacuating people nearby and those who are outdoors in direct view of the scene. When additional help arrives, expand the area to be evacuated downwind and crosswind to at least the extent recommended in this guidebook.

Even after people move to the distances recommended, they may not be completely safe from harm. They should not be permitted to gather at such distances. Send evacuees to a definite place, by a specific route, far enough away so they will not have to relocate again if the wind shifts.

Shelter-in-place means people should seek shelter inside a building and remain inside until the danger passes. **It is vital for first responders to maintain communications with sheltered-in-place people** so that they are advised about changing conditions.

Sheltering-in-place is used either when:

- evacuating the public would cause greater risk than staying where they are
- an evacuation cannot be safely performed

Direct the people inside to:

- close all doors and windows
- shut off all ventilating, heating and cooling systems
- stay far from windows to avoid shattered glass and projectile metal fragments in the event of a fire and/or explosion
- seal cracks around doors, windows and vents with duct tape or wet cloths
- tune in to local media, and remain inside until told it is safe to leave by first responders or emergency response authorities
- breathe through a wet cloth until an all clear has been communicated

Vehicles can offer some protection for a short period if the windows are closed and the ventilation systems are shut off. Vehicles are not nearly as effective as buildings for in-place protection.

PROTECTIVE ACTION DECISION FACTORS TO CONSIDER

The choice of protective actions for a given situation depends on a number of factors. For some cases, evacuation may be the best option; in others, sheltering-in-place may be the best course. Sometimes, these two actions may be used in combination. In any emergency, officials need to quickly give the public instructions. The public will need continuing information and instructions while being evacuated or sheltered-in-place.

Proper evaluation of the factors listed below will determine the effectiveness of evacuation or in-place protection (shelter-in-place). The importance of these factors can vary with emergency conditions. In specific emergencies, other factors may need to be identified and considered as well. This list indicates what kind of information may be needed to make the initial decision.

The hazardous materials/dangerous goods:

- degree of health hazard
- chemical and physical properties
- amount involved
- containment/control of release
- rate of vapor movement

The population threatened:

- location
- number of people
- time available to evacuate or shelter-in-place
- ability to control evacuation or shelter-in-place
- building types and availability
- special institutions or populations, e.g., nursing homes, hospitals, prisons

The weather conditions:

- effect on vapor and cloud movement
- potential for change
- effect on evacuation or shelter-in-place

NOTE: Every hazardous materials/dangerous goods incident is different. Each will have special problems and concerns. Actions to protect the public must be carefully selected. This section can help with **initial** decisions on how to protect the public. Officials must continue to gather information and monitor the situation until the threat is removed.

The following table can help to decide if evacuation or sheltering-in-place is the best option:

Consider Evacuation:	**Consider Sheltering-in-place:**
Vapors are flammable.	Vapors are toxic, and people are likely to be exposed by evacuating.
Buildings cannot be closed tightly.	Buildings can be quickly sealed by closing all windows and ventilation systems, if applicable.
The vapors are continuously generated and will hug the ground, or it will take a long time for the vapors to clear the area.	The vapors will quickly rise in the air column or rapidly dissipate.
For anyone outdoors.	For anyone already indoors.
There are few people to evacuate.	There are too many people to evacuate for current available resources.
The threat seems stable but long-lasting.	Circumstances are changing too quickly to evacuate safely.

BACKGROUND ON TABLE 1 – INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

Initial isolation and protective action distances in this guidebook were determined for small and large spills occurring during day or night. The overall analysis, statistical in nature, was conducted using:

- state-of-the-art emission rate and dispersion models
- statistical release data from the U.S. Department of Transportation (DOT) Hazardous Materials Information System (HMIS) database
- meteorological observations from more than 120 locations in the United States, Canada, and Mexico
- the most current toxicological exposure guidelines

For each chemical, thousands of hypothetical releases were modeled to account for the statistical variance in both release amount and atmospheric conditions. Based on this statistical sample, they selected the 90th percentile protective action distance for each chemical and category to appear in the table. A brief description of the analysis is provided below.

A detailed report outlining the methodology and data used to generate the initial isolation and protective action distances may be obtained from the U.S. DOT, Pipeline and Hazardous Materials Safety Administration (PHMSA).

DESCRIPTION OF THE ANALYSIS

Release amounts and emission rates into the atmosphere were statistically modeled based on:

- data from the U.S. DOT HMIS database
- container types and sizes authorized for transport as specified in 49 CFR §172.101 and Part 173
- physical properties of the individual materials
- atmospheric data from a historical database

For liquefied gases, which can flash to form both a vapor/aerosol mixture and an evaporating pool, the emission model calculated one or both of:

- the release of vapor due to evaporation of pools on the ground
- direct release of vapors from the container

The emission model also calculated the emission of toxic vapor by-products generated from spilling water-reactive materials in water.

Small spills involve 208 liters (55 US gallons) or less.

Large spills involve greater quantities.

Downwind dispersion of the vapor was estimated for each case modeled. Using a database containing hourly meteorological data from 120 American, Canadian, and Mexican cities, the atmospheric parameters affecting the dispersion and the emission rate were selected.

The dispersion calculation accounted for both the:

- time-dependent emission rate from the source
- density of the vapor plume (i.e., heavy gas effects)

Since atmospheric mixing is less effective at dispersing vapor plumes during nighttime, day and night were separated in the analysis.

In the table:

- **day** refers to time periods after sunrise and before sunset
- **night** includes all hours between sunset and sunrise

Toxicological short-term exposure guidelines for the materials were applied to determine the downwind distance to which people may:

- become incapacitated and unable to take protective action
- incur serious health effects after a single, or rare, exposure

When available, toxicological exposure guidelines were chosen from AEGL-2 or ERPG-2 emergency response guidelines. AEGL-2 values were the first choice.

For materials without AEGL-2 or ERPG-2 values, emergency response guidelines were estimated based on lethal concentration limits derived from animal-based-studies. This approach was recommended by an independent panel of toxicological experts from industry and academia.