

The **CAMEO**<sup>®</sup> Software System  
Computer-Aided Management of  
Emergency Operations



# ALOHA<sup>®</sup>

Areal Locations of Hazardous Atmospheres

**USER'S MANUAL/February 2006**



**U.S. ENVIRONMENTAL PROTECTION AGENCY**

Office of Emergency Management  
Washington, D.C.



**NATIONAL OCEANIC AND ATMOSPHERIC  
ADMINISTRATION**

Office of Response and Restoration/  
Hazardous Materials Response Division  
Seattle, Washington



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# Table of Contents

---

<b>Welcome to ALOHA .....</b>	<b>1</b>
About ALOHA .....	1
Program purpose .....	1
Basic program organization .....	1
ALOHA's menu bar.....	3
Getting help.....	4
In Windows.....	4
On a Macintosh.....	4
How to use this manual.....	4
Modeling in ALOHA.....	5
Introduction to dispersion modeling .....	5
What is dispersion?.....	6
Gaussian model.....	6
Heavy gases .....	7
Classification of heavy gases.....	7
Flash-boiling and two-phase flow.....	7
ALOHA can choose a dispersion model for you.....	8
Introduction to fires and explosions.....	8
What is a fire? .....	9
Thermal Radiation Levels of Concern.....	10
What is an explosion?.....	11
Overpressure .....	11
Overpressure Levels of Concern.....	12
Hazardous fragments .....	13
Types of fire and explosion scenarios.....	13
Jet fires.....	14
Pool fire.....	14
BLEVEs .....	15
Fireball .....	15
Explosion and hazardous fragments .....	15
Flash fires (flammable area) .....	16

Vapor cloud explosions .....	16
Deflagration and detonation.....	17
Congestion and confinement .....	17
ALOHA's limitations .....	18
Conditions that can produce unreliable results .....	18
Very low wind speeds.....	18
Very stable atmospheric conditions.....	18
Wind shifts and terrain steering effects .....	19
Concentration patchiness .....	20
Effects that are not modeled .....	21
Byproducts from fires, explosions, or chemical reactions.....	21
Particulates.....	21
Chemical mixtures .....	21
Terrain.....	21
Hazardous fragments .....	21
<b>Installing ALOHA .....</b>	<b>22</b>
Before you install ALOHA.....	22
Memory and hard disk space requirements .....	22
In Windows.....	22
On a Macintosh.....	22
If you already have a previous version of ALOHA.....	22
Installing ALOHA in Windows.....	23
Making the installation .....	23
Installing ALOHA on a Macintosh.....	23
Making the installation .....	23
<b>Learning the Basics .....</b>	<b>24</b>
Guided tour .....	24
Describing the time and place.....	25
Choosing a chemical.....	27
Describing the weather .....	27
Describing the release.....	29
Checking the Calculation and Display Options settings.....	33
Creating a threat zone plot .....	34
Determining threat levels at a specific location.....	37
Exiting (Quitting) ALOHA.....	39

<b>Examples .....</b>	<b>40</b>
Example 1: A Tank Source (Puddle and Pool Fire).....	40
Choosing a location and a chemical .....	40
Entering weather information .....	42
Describing the release .....	44
Checking the Calculation and Display Options Settings .....	49
Choosing LOCs and creating a threat zone plot .....	49
Modeling a second scenario: pool fire .....	52
Choosing LOCs and creating a threat zone plot for the pool fire .....	54
Example 2: A Tank Source (Multiple Scenarios) .....	57
Choosing a location and a chemical .....	57
Entering weather information .....	59
Describing the release .....	61
Choosing LOCs and creating a threat zone plot for a BLEVE .....	63
Modeling a second scenario: flash fire or vapor cloud explosion .....	65
Choosing LOCs and creating threat zone plots for a flammable vapor cloud .....	67
Modeling a third scenario: jet fire .....	73
Choosing LOCs and creating a threat zone plot for a jet fire .....	74
Example 3: A Direct Source and a MARPLOT Map .....	76
Choosing a location and a chemical .....	76
Entering weather information .....	78
Describing the release .....	79
Choosing LOCs and creating a threat zone plot .....	81
Using MARPLOT .....	83
 <b>Reference .....</b>	 <b>90</b>
File menu .....	90
New .....	90
Open .....	90
Response Mode .....	90
Planning Mode .....	90
Close .....	91
Save and Save As .....	91
Print, Print All, and Print or Page Setup .....	91
Quit or Exit .....	91
Edit menu .....	91
Copy .....	91

SiteData menu.....	92
Location .....	92
Selecting a location.....	92
Adding information about a U.S. city.....	93
Adding a location outside the U.S. ....	94
Modifying a location.....	95
Deleting a location .....	95
Building Type .....	95
Date & Time .....	97
SetUp menu.....	98
Chemical .....	98
Selecting a pure chemical .....	99
<b>Selecting a chemical solution .....</b>	<b>99</b>
Reactive chemicals .....	100
Chemical information in the Text Summary window .....	100
Chemical data .....	101
Adding a chemical to the library.....	103
Modifying a chemical entry in the library .....	103
Deleting a chemical from the library .....	104
Atmospheric.....	104
User Input .....	104
Wind speed, direction, and measurement height .....	105
Ground roughness .....	107
Cloud cover.....	109
Air temperature .....	109
Stability class .....	110
Inversion height .....	111
Humidity .....	112
SAM Station .....	113
Choosing a SAM.....	113
Transmitting SAM data to ALOHA .....	113
Using a SAM during an incident .....	114
Choosing the correct port for receiving SAM data.....	114
Choosing a radio frequency .....	114
Setting up ALOHA when you're using a SAM.....	114
SAM Options .....	115
Archive Data.....	116



Raw Data.....	117
Processed Data.....	117
Wind Rose.....	118
Monitoring a long-term release.....	118
Source .....	119
ALOHA's duration limits .....	120
ALOHA reports release rate .....	121
When you're using a SAM .....	121
Direct source .....	121
Direct release of gas into the atmosphere .....	122
Source height .....	123
Puddle Source .....	123
Type of Puddle.....	124
Evaporating Puddle.....	124
Area and Volume .....	126
Ground Type and Initial Temperatures.....	126
Tank .....	127
Liquefied gases .....	128
Tank Size and Orientation .....	129
Chemical State and Temperature.....	129
Liquid in a tank.....	130
Gas in a tank .....	131
Chemical of unknown state in a tank.....	131
Type of Tank Failure .....	132
Percent Mass in Fireball .....	133
Area and Type of Leak .....	134
Height of the Tank Opening .....	135
Puddle formation.....	135
Gas Pipeline .....	137
Pipe source inputs .....	137
Source strength information in the Text Summary.....	138
Calculation Options .....	139
Display menu .....	140
Threat Zone.....	140
Level of Concern .....	141
Vapor Cloud Explosion Parameters.....	141
Threat zone plot .....	143

Interpreting a threat zone .....	144
Displaying threat zones in other applications .....	144
Threat at Point.....	144
Using fixed (east-west and north-south) coordinates .....	145
Using relative (downwind and crosswind) coordinates:.....	145
Threat at Point results .....	145
Text Summary.....	147
Source Strength.....	147
Constant source strength.....	148
Variable source strength .....	148
Source strength averaging.....	149
Tile and Stack Windows .....	149
Display Options .....	149
Sharing menu .....	150
Items in the Sharing menu .....	150
CAMEO menu .....	150
MARPLOT menu .....	151
Using MARPLOT.....	151
<b>Troubleshooting .....</b>	<b>153</b>
<b>Bibliography .....</b>	<b>157</b>
<b>Glossary.....</b>	<b>159</b>
<b>Index .....</b>	<b>178</b>

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# Welcome to ALOHA

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Welcome to ALOHA! This chapter contains an overview of ALOHA®, an explanation of how to use this manual and ALOHA's on-screen help, and a discussion of basic concepts.

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## About ALOHA

### Program purpose

ALOHA (Areal Locations of Hazardous Atmospheres) is a computer program designed especially for use by people responding to chemical releases, as well as for emergency planning and training. ALOHA models key hazards—toxicity, flammability, *thermal radiation* (heat), and *overpressure* (explosion blast force)—related to chemical releases that result in toxic gas dispersions, fires, and/or explosions. (Note: In versions prior to 5.4, ALOHA only models the toxic threat: specifically, how a toxic gas cloud might disperse in the atmosphere after an accidental chemical release.)

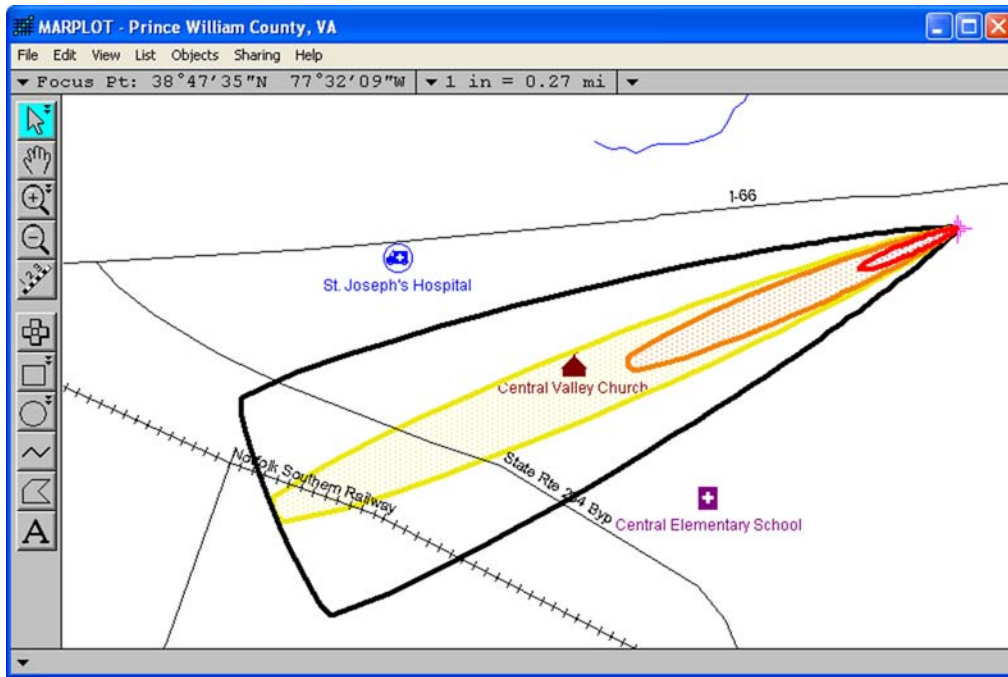
ALOHA runs quickly on small computers (Microsoft® Windows® or Macintosh®) that are easily transportable. It is designed to be easy to use so that you can operate it successfully during high-pressure situations. Its chemical library contains information about the physical properties of approximately 1,000 common hazardous chemicals. Its computations represent a compromise between accuracy and speed; ALOHA has been designed to produce good results quickly enough to be of use to responders. ALOHA is designed to minimize operator error. It checks information that you enter and warns you when you make a mistake. ALOHA's on-screen help offers you quick access to explanations of ALOHA's features and computations, as well as background information to help you interpret its output.

### Basic program organization

To use ALOHA, you'll typically perform several basic steps:

1. Indicate the city where a chemical release is occurring and the date and time;
2. Choose the chemical of concern from ALOHA's library of chemical information;
3. Enter information about current weather conditions;
4. Describe how the chemical is escaping from containment; and

5. Ask ALOHA to display a *threat zone* plot, showing one or more areas where a hazard—toxicity, flammability, thermal radiation, or damaging overpressure—may exceed key *Levels of Concern (LOCs)* and pose a threat to people and property. If three LOCs are chosen, ALOHA will display the threat zones in red, orange, and yellow. The red threat zone represents the worst hazard and the orange and yellow threat zones represent areas of decreasing hazard. ALOHA can display this threat zone plot on an electronic map of your city using MARPLOT®, as shown below, and ALOHA's threat zones can also be exported to GIS systems.



You can also use the *Threat at Point* feature to obtain specific information about the hazards at points of interest (such as schools and hospitals) in and around the threat zones. ALOHA will display the threat at a point either as a graph or as text. For example, if you choose to see the threat at a point for a toxic gas dispersion scenario, ALOHA will display a graph showing predicted indoor and outdoor chemical concentrations at the location for the first hour after the release.

#### Threat Zones and Footprints

In versions of ALOHA prior to 5.4, the term *footprint* was used instead of threat zone. The two terms are equivalent.

You can save ALOHA results as archive files, and you can copy and paste graphs, plots, and text information from ALOHA into documents or reports in word processing or graphics programs.

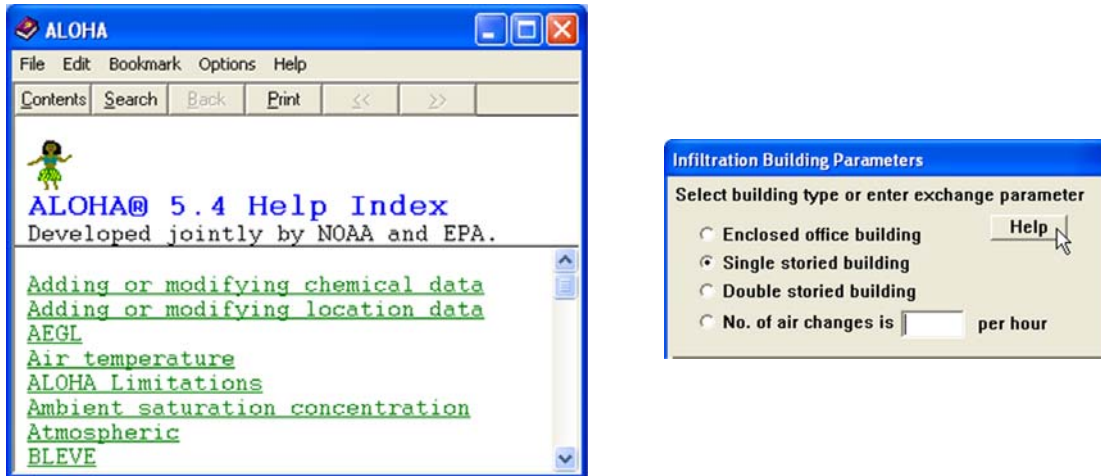
## ALOHA's menu bar

Perform basic ALOHA operations by moving left-to-right through the seven menus in its menu bar:

- **File** and **Edit**: Choose items from these two menus to perform basic operations, such as opening, closing, and saving files; printing the contents of ALOHA's windows; and copying text and graphics displayed in ALOHA.
- **SiteData**: Choose items from the SiteData menu to enter information about the release: (a) the date and time, (b) location, and (c) the type of buildings downwind of a toxic gas release.
- **SetUp**: Choose items from the SetUp menu to (a) select a chemical from ALOHA's chemical library (or to add a chemical to the library), (b) indicate weather conditions (manually or by connecting your computer to a portable meteorological station), (c) "set the source" (describe how the chemical is escaping from containment), and (d) choose the type of dispersion calculations for ALOHA to make (ALOHA can predict the movement of either *neutrally buoyant* clouds that are about as dense as air and *heavy gas* clouds that are denser than air).
- **Display**: Choose items from the Display menu to indicate the ALOHA results that you would like to see and to choose how you would like the information to be displayed. Choose to tile or stack ALOHA's windows and choose whether to see ALOHA's results displayed in English or metric units. Choose one or more LOCs and display the threat zone plot. If applicable given your scenario, you may also choose to display a threat at point report or a *source strength* graph.
- **Sharing**: Choose items from this menu to (a) display an ALOHA threat zone on a background map using MARPLOT, the CAMEO® mapping module, or (b) see detailed information about the chemical you've selected, displayed in CAMEO's Response Information Data Sheets (RIDS) module.
- **Help**: Choose items from the Help menu to search the Help Index by different methods.

## Getting help

On-screen help is available at any time when ALOHA is running. The Help Index can be accessed through the menu bar. Also, most screens in ALOHA have Help buttons that take you to specific Help Topics related to that screen.



**In Windows.** To open the Help Index, select **Contents** from the **Help** menu. When the index appears, click any topic name to view a discussion of that topic. When you've finished reading about that topic, click **Contents** to return to the Help Index. When you are ready to go back to using ALOHA, close or minimize the Help window.

**On a Macintosh.** To open the Help Index, select **Topics** from the **Help** menu. When the index appears, highlight a topic name, then click **Select** to view a discussion of that topic. When you've finished reading the topic discussion, click either **Topics** or **Cancel** to return to the Help Index to select another topic, **Print** to print the Help screen, or **Copy** to copy the discussion text to the clipboard.

## How to use this manual

This manual includes six chapters. Begin here in Chapter 1 by reviewing a discussion of basic concepts. Turn to Chapter 2 for instructions on installing ALOHA, and to Chapter 3 for a step-by-step ALOHA tutorial. Chapter 4 contains ALOHA example problems. Turn to Chapter 5 for descriptions of the main features of ALOHA. Sections in this chapter include explanations of each of ALOHA's menus, along with background information to help you to better understand ALOHA's computations. Review Chapter 6 for trouble-shooting advice. At the back of the manual, you'll find a bibliography, a glossary, and an index.

**Note:** Terms displayed in italics are defined in the glossary.

## Modeling in ALOHA

ALOHA models three hazard categories: toxic gas dispersion, fires, and explosions. ALOHA employs several different models, including an *air dispersion model* that it uses to estimate the movement and dispersion of chemical gas clouds. From this model, ALOHA is able to estimate the toxic gas dispersion, the overpressure values from a *vapor cloud explosion*, or the *flammable areas* of a vapor cloud. ALOHA uses additional models to estimate the hazards associated with other fires and explosions. ALOHA can solve problems rapidly and provide results in a graphic, easy-to-use format. This can be helpful during an emergency response or planning for such a response.

ALOHA originated as a tool to aid in emergency response. It has evolved over the years into a tool used for a wide range of response, planning, and academic purposes. However, you must still rely on your own common sense and experience when deciding how to respond to a particular incident. There are features that would be useful in some of ALOHA's models (in the dispersion model, for example, equations accounting for site topography) that have not been included in ALOHA because they would require extensive input and computational time. ALOHA's most important limitations are discussed later in this chapter.

### How accurate is ALOHA?

Keep in mind that ALOHA is only a tool. Its usefulness depends on the accuracy of the information you enter into ALOHA and on your accurate interpretation of the data and how you apply it to each situation.

## Introduction to dispersion modeling

Many different types of air dispersion models exist. They range from simple equations that can be solved by hand to complex models that require massive amounts of input data and powerful computers. The type of model appropriate for a particular use depends on the scale of the problem, the level of detail available for input and required for output, the background of the intended user, and the time available to wait for the model computations to be completed.

ALOHA was designed with first responders in mind. Its air dispersion model is intended to be used to estimate the areas near a short-duration chemical release where key hazards—toxicity, flammability, thermal radiation, or overpressure—may exceed user-specified Levels of Concern (LOCs). (Note: If the released chemical is not flammable, toxicity is the only air dispersion hazard modeled in ALOHA.) ALOHA is not intended for use with radioactive chemical releases, nor is ALOHA intended to be used for permitting of stack gas or modeling chronic, low-level (“fugitive”) emissions. Other models are designed to address larger scale and/or air quality issues (Turner and Bender 1986). Since most first responders do not have dispersion modeling backgrounds, ALOHA has been designed to require input data that are either easily obtained or estimated at the scene of an accident. ALOHA's on-screen help can assist you in choosing inputs.

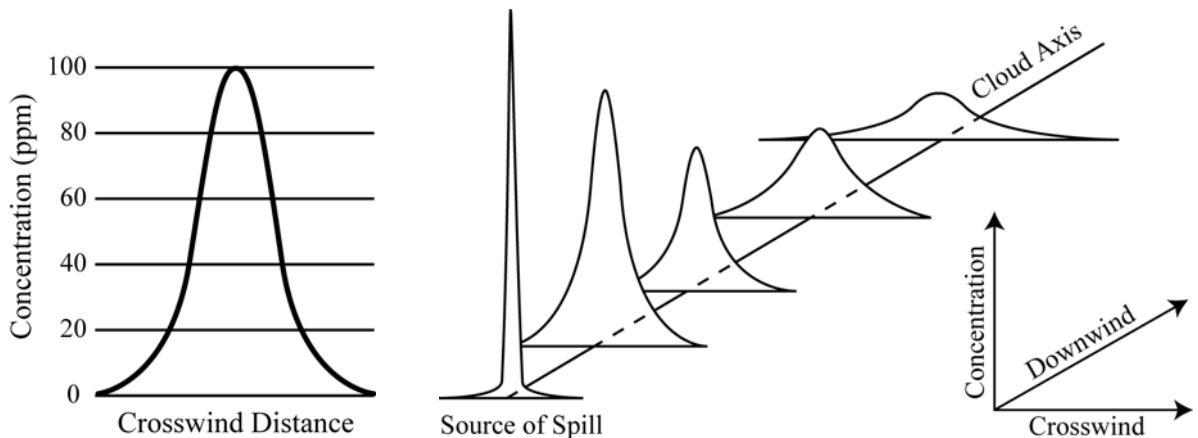
## What is dispersion?

*Dispersion* is a term used by modelers to include advection (moving) and diffusion (spreading). A dispersing vapor cloud will generally move (advect) in a downwind direction and spread (diffuse) in a *crosswind* and vertical direction (crosswind is the direction perpendicular to the wind). A cloud of gas that is denser or heavier than air (called a heavy gas) can also spread upwind to a small extent.

ALOHA can model the dispersion of a cloud of pollutant gas in the atmosphere and display a diagram that shows an overhead view of the regions, or threat zones, in which it predicts that key hazard levels (LOCs) will be exceeded. This diagram is called a threat zone plot. To obtain a threat zone estimate, you must first choose at least one LOC. (ALOHA will suggest default LOCs, and you may keep those or choose up to three other LOCs.) For toxic gas dispersion scenarios, an LOC is a threshold concentration of the gas at ground level—usually the concentration above which a hazard is believed to exist. The type of LOC will depend on the scenario. For each LOC you choose, ALOHA estimates a threat zone where the hazard is predicted to exceed that LOC at some time after a release begins. These zones are displayed on a single threat zone plot. If three LOCs are chosen, ALOHA will display the threat zones in red, orange, and yellow. When you use ALOHA’s default LOCs, the red zone represents the worst hazard.

There are two separate dispersion models in ALOHA: *Gaussian* and *heavy gas*.

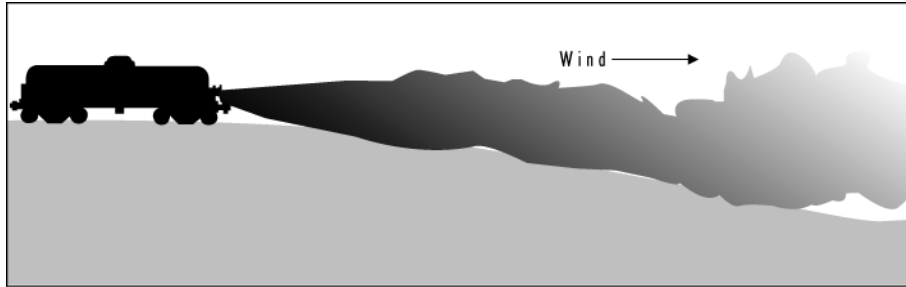
**Gaussian model.** ALOHA uses the Gaussian model to predict how gases that are about as buoyant as air will disperse in the atmosphere. Such neutrally buoyant gases have about the same density as air. According to this model, wind and atmospheric turbulence are the forces that move the molecules of a released gas through the air, so as an escaped cloud is blown downwind, “turbulent mixing” causes it to spread out in the crosswind and upward directions. According to the Gaussian model, a graph of gas concentration within any crosswind slice of a moving pollutant cloud looks like a bell-shaped curve, high in the center (where concentration is highest) and lower on the sides (where concentration is lower), as in Figure 1-1. At the point of a release, the pollutant gas concentration is very high, and the gas has not diffused very far in the crosswind and upward directions, so a graph of concentration in a crosswind slice of the cloud close to the source looks like a spike. As the pollutant cloud drifts farther downwind, it spreads out and the “bell shape” becomes wider and flatter.



**Figure 1-1.** Gaussian distribution (left) and Gaussian spread (right).



**Heavy gases.** When a gas that is heavier than air is released, it initially behaves very differently from a neutrally buoyant gas. The heavy gas will first “slump,” or sink, because it is heavier than the surrounding air. As the gas cloud moves downwind, gravity makes it spread; this can cause some of the vapor to travel upwind of its release point (Figure 1-2). Farther downwind, as the cloud becomes more diluted and its density approaches that of air, it begins behaving like a neutrally buoyant gas. This takes place when the concentration of heavy gas in the surrounding air drops below about 1 percent (10,000 *parts per million*). For many small releases, this will occur in the first few yards (meters). For large releases, this may happen much further downwind.



**Figure 1-2.** Cloud spread as a result of gravity.

The heavy gas dispersion calculations that are used in ALOHA are based on those used in the DEGADIS model (Spicer and Havens 1989), one of several well-known heavy gas models. This model was selected because of its general acceptance and the extensive testing that was carried out by its authors.

**Classification of heavy gases.** A gas that has a *molecular weight* greater than that of air (the average molecular weight of air is about 29 kilograms per kilomole) will form a heavy gas cloud if enough gas is released. Gases that are lighter than air at room temperature, but that are stored in a *cryogenic* (low-temperature) state, can also form heavy gas clouds. If the density of a gas cloud is substantially greater than the density of the air (the density of air is about 1.1 kilograms per cubic meter), ALOHA considers the gas to be heavy.

**Flash-boiling and two-phase flow.** Many substances that are gases under normal pressures and temperatures are stored under pressures high enough to liquefy them. For example, propane is a gas at normal pressures and temperatures but is often stored under pressure as a liquid. When a tank rupture or broken valve causes a sudden pressure loss in a tank of liquefied gas, the liquid boils violently and the tank contents foam up, filling the tank with a mixture of gas and fine liquid droplets (called aerosol). *Flash-boiling* is the term for that sudden vaporization of a liquid caused by a loss of pressure.

When the liquid and gas phases of a chemical escape together from a ruptured tank, the release is called a *two-phase flow*. When a two-phase mixture escapes from storage, the release rate can be significantly greater than that for a release of pure gas. The two-phase mixture that escapes into the atmosphere may behave like a heavy gas cloud. The cloud is heavy in part because it is initially cold, and therefore denser than it would be at ambient temperatures, and also because it consists of a two-phase mixture. The tiny *aerosol* droplets mixed into the cloud act to weigh the cloud down and make it denser than a pure gas cloud, and their evaporation cools the cloud.

**ALOHA can choose a dispersion model for you.** ALOHA can automatically choose whether to predict the dispersion of a chemical as a Gaussian or heavy gas release (it bases this choice mainly on molecular weight, size of the release, and temperature of the gas cloud). But sometimes you may want to specify the model to use rather than letting ALOHA choose. In particular, when a chemical with a molecular weight less than that of air has been stored at a low temperature or under high pressure, it can behave like a heavy gas (ammonia is an example of such a chemical). If you have chosen one of these chemicals, depending on how you model its release, ALOHA may not have enough information about the release to determine whether a heavy gas could be formed. In such a case, ALOHA will make Gaussian calculations, but will alert you that you should try running the heavy gas model as well. In such cases, you should re-run ALOHA using the heavy gas calculations, and compare the threat zone estimates.

## Introduction to fires and explosions

Beginning with ALOHA version 5.4, you can model fire and explosion scenarios as well as toxic gas dispersion scenarios. This section provides basic information about fires and explosions, and then explains how to model fires and explosions in ALOHA.

ALOHA allows you to model chemical releases from four types of sources: Direct, Puddle, Tank, and Gas Pipeline. Refer to Table 1-1 to see what types of scenarios you can run in ALOHA from each source. For a more detailed discussion on sources, refer to the Reference chapter.

**Table 1-1: ALOHA sources and scenarios.**

Source	Toxic Scenarios	Fire Scenarios	Explosion Scenarios
<b>Direct</b>			
Direct Release	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
<b>Puddle</b>			
Evaporating	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Pool Fire)		Pool Fire	
<b>Tank</b>			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning		Jet Fire or Pool Fire	
BLEVE		BLEVE (Fireball and Pool Fire)	
<b>Gas Pipeline</b>			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Jet Fire)		Jet Fire	

**What about chemicals that are flammable and toxic?**

Many of the chemicals in ALOHA's chemical library are *flammable*, in addition to being toxic and volatile enough to be potential air hazards. For those chemicals, you can model not only the toxic threat posed by the release of that chemical, but also the fires and/or explosions that the chemical could potentially cause. However, ALOHA cannot model these threats at the same time.

If a flammable and toxic chemical—such as acrolein—has been released, run a toxic gas dispersion scenario first. Next, run all of the appropriate fire and explosions scenarios. Finally, consider all of the threat zone plots (the estimates will vary with each scenario) and any additional site-specific data and use that information to decide how you are going to respond to the incident. In many situations involving a flammable and toxic chemical, the area encompassed by the toxic threat zone will be greater than the threat zones associated with fire and explosion scenarios. It is essential that you evaluate all of the scenario options before developing your response plan.

**What is a fire?**

A fire is a complex chain reaction where a fuel combines with oxygen to generate heat, smoke, and light. Most chemical fires will be triggered by one of the following ignition sources: sparks, static electricity, heat, or flames from another fire. Additionally, if a chemical is above its autoignition temperature it will spontaneously catch on fire without an external ignition source.

There are several properties that measure how readily—that is, how easily—a chemical will catch on fire. Here we'll discuss three of these properties: *volatility*, *flash point*, and flammability limits. Volatility is a measure of how easily a chemical evaporates. A flammable liquid must begin to evaporate—forming a vapor above the liquid—before it can burn. The more volatile a chemical, the faster it evaporates and the quicker a flammable vapor cloud is formed. The flash point is the lowest temperature where a flammable liquid will evaporate enough to catch on fire if an ignition source is present. The lower the flash point, the easier it is for a fire to start. Flammability limits, called the *Lower Explosive Limit (LEL)* and the *Upper Explosive Limit (UEL)*, are the boundaries of the flammable region of a vapor cloud. These limits are percentages that represent the concentration of the fuel—that is, the chemical—vapor in the air. If the chemical vapor comes into contact with an ignition source, it will burn only if its fuel-air concentration is between the LEL and the UEL. To some extent, these properties are interrelated—chemicals that are highly volatile and have a low flash point will usually also have a low LEL.

Once the chemical catches on fire, three things need to be present to keep the fire going: fuel (the chemical), oxygen, and heat. This is often referred to as the fuel triangle. If any one of those components is eliminated, then the fire will stop burning.

Like other reactions, a fire can also generate byproducts—*smoke*, soot, ash, and new chemicals formed in the reaction. Some of these reaction byproducts can be hazardous themselves. While ALOHA cannot model all the complex processes that happen in a fire (like the generation and distribution of byproducts), it can predict the area where the heat radiated by the fire—called thermal radiation—could be harmful. Thermal radiation is the primary hazard associated with fires. However, it is also important to consider the hazards associated with any secondary fires and explosions that may occur.

**Thermal Radiation Levels of Concern.** A Thermal Radiation Level of Concern (LOC) is a threshold level of thermal radiation, usually the level above which a hazard may exist. When you run a fire scenario, ALOHA will suggest three default LOC values. ALOHA uses three threshold values (measured in kilowatts per square meter and denoted as kW/m<sup>2</sup>) to create the default threat zones:

- Red: 10 kW/m<sup>2</sup> (potentially lethal within 60 sec);
- Orange: 5 kW/m<sup>2</sup> (second-degree burns within 60 sec); and
- Yellow: 2 kW/m<sup>2</sup> (pain within 60 sec).

The thermal radiation effects that people experience depend upon the length of time they are exposed to a specific thermal radiation level. Longer exposure durations, even at a lower thermal radiation level, can produce serious physiological effects. The threat zones displayed by ALOHA represent thermal radiation levels; the accompanying text indicates the effects on people who are exposed to those thermal radiation levels but are able to seek shelter within one minute.

ALOHA's default thermal radiation values are based on a review of several widely accepted sources for this topic (e.g., American Institute of Chemical Engineers 1994, Federal Emergency Management Agency et al. 1988, and Lees 2001).

If you set your own LOC values, consider Table 1-2 (Federal Emergency Management Agency et al. 1988), which lists some physiological effects at specific thermal radiation levels and durations (on bare skin):

**Table 1-2: Thermal radiation burn injury criteria.**

Radiation Intensity (kW/m <sup>2</sup> )	Time for Severe Pain (s)	Time for 2nd Degree Burns (s)
1	115	663
2	45	187
3	27	92
4	18	57
5	13	40
6	11	30
8	7	20
10	5	14
12	4	11

**Note:** The durations that correspond to effects like pain or second-degree burns can vary considerably, depending on circumstances. The effects above were observed on bare skin that was exposed directly to the thermal radiation. Some types of clothing can serve as a protective barrier against thermal radiation and can affect the exposure duration. However, exposure duration should be kept to a minimum, even at low levels of thermal radiation.

## **What is an explosion?**

The most basic definition of an explosion is a sudden, intense release of energy that often produces a loud noise, high temperatures, and flying debris, and generates a pressure wave. There are many types of explosions and the causes and effects will vary. ALOHA primarily models explosions that are the result of accidents involving industrial chemicals. Intentional explosions will generally—but not always—result in greater hazard damage.

Consider three primary hazards when dealing with an explosion: thermal radiation, overpressure, and hazardous fragments (flying debris). All three of these hazards are not present in every explosion and the severity of the hazard will depend on the explosion. These hazards typically last only for a brief period directly following the explosion. However, it is important to consider the potential for secondary explosions and fires to occur before deciding that these hazards no longer exist.

**Overpressure.** A major hazard associated with any explosion is overpressure. Overpressure, also called a blast wave, refers to the sudden onset of a pressure wave after an explosion. This pressure wave is caused by the energy released in the initial explosion—the bigger the initial explosion, the more damaging the pressure wave. Pressure waves are nearly instantaneous, traveling at the speed of sound.

Although a pressure wave may sound less dangerous than a fire or hazardous fragments, it can be just as damaging and just as deadly. The pressure wave radiates outward like a giant burst of air, crashing into anything in its path (generating hazardous fragments). If the pressure wave has enough power behind it, it can lift people off the ground and throw them up against nearby buildings or trees. Additionally, blast waves can damage buildings or even knock them flat—often injuring or killing the people inside them. The sudden change in pressure can also affect pressure-sensitive organs like the ears and lungs. The damaging effects of the overpressure will be greatest near the source of the explosion and lessen as you move farther from the source.

When you use ALOHA to predict an explosion's effects, assess the surroundings at the explosion site as you interpret ALOHA's threat zone plot. Large objects (like trees and buildings) in the path of the pressure wave can affect its strength and direction of travel. For example, if many buildings surround the explosion site, expect the actual overpressure threat zone to be somewhat smaller than ALOHA predicts. But at the same time, more hazardous fragments could be generated as the blast causes structural damage to those buildings.

**Overpressure Levels of Concern.** An Overpressure Level of Concern (LOC) is a threshold level of pressure from a blast wave, usually the pressure above which a hazard may exist. When you run a vapor cloud explosion scenario, ALOHA will suggest three default LOC values. ALOHA uses three threshold values to create the default threat zones:

- Red: 8.0 psi (destruction of buildings);
- Orange: 3.5 psi (serious injury likely); and
- Yellow: 1.0 psi (shatters glass).

ALOHA’s default overpressure values are based on a review of several widely accepted sources for this topic (e.g., American Institute of Chemical Engineers 1994, Federal Emergency Management Agency et al. 1988, and Lees 2001).

If you choose to set your own LOC values, consider Table 1-3 (Lees 1980), which relates overpressure values to the structural and physiological effects produced.

**Table 1-3: Explosion overpressure damage estimates.**

Overpressure* (psig)	Expected Damage
0.04	Loud noise (143 dB); sonic boom glass failure.
0.15	Typical pressure for glass failure.
0.40	Limited minor structural damage.
0.50-1.0	Windows usually shattered; some window frame damage.
0.70	Minor damage to house structures.
1.0	Partial demolition of houses; made uninhabitable.
1.0-2.0	Corrugated metal panels fail and buckle. Housing wood panels blown in.
1.0-8.0	Range for slight to serious laceration injuries from flying glass and other missiles.
2.0	Partial collapse of walls and roofs of houses.
2.0-3.0	Non-reinforced concrete or cinder block walls shattered.
2.4-12.2	Range for 1-90% eardrum rupture among exposed populations.
2.5	50% destruction of home brickwork.
3.0	Steel frame building distorted and pulled away from foundation.
5.0	Wooden utility poles snapped.
5.0-7.0	Nearly complete destruction of houses.
7.0	Loaded train cars overturned.
9.0	Loaded train box cars demolished.
10.0	Probable total building destruction.
14.5-29.0	Range for the 1-99% fatalities among exposed populations due to direct blast effects.
* These are peak pressures formed in excess of normal atmospheric pressure by blast and shock waves.	

**Hazardous fragments.** One of the major hazards associated with any explosion is flying debris (hazardous fragments) propelled by the explosion's pressure wave. Hazardous fragments come from two primary sources: container fragments and debris from the surrounding area. **ALOHA does not model the hazardous fragments threat.**

If an explosion is likely to occur, first responders must be aware of the possibility of hazardous fragments and take necessary precautions to shield responders and others from the potentially fatal fragments. **Some hazardous fragments may be projected into areas well beyond those affected by the thermal or overpressure explosion hazards.**

Analysis of data from multiple accident investigations revealed several broad trends that responders should keep in mind regarding hazardous fragments (Leslie and Birk 1991):

- 80% of fires that lead to container rupture result in missiles (e.g., hazardous fragments);
- 80% of fragments from liquid petroleum gas (LPG) accidents travel less than 200 meters (660 feet);
- Spherical containers produce more missiles than cylindrical containers, spheres average 8.3 missiles and cylinders average less than 4 missiles;
- End tubes from cylindrical containers travel further than other types of fragments;
- Smaller vessels project fragments further than larger ones; and
- Missiles tend to export fire with them.

**Why doesn't ALOHA model hazardous fragments?**

It is difficult to predict the distribution of hazardous fragments with any accuracy because there are too many unknown—or unknowable—variables. The two main issues of concern are (1) the number of hazardous fragments, and (2) where the fragments will land.

## Types of fire and explosion scenarios

ALOHA models the five types of fire and explosion scenarios that are most frequently associated with chemical releases: *Jet Fires*, *Pool Fires*, *BLEVEs*, *Flammable Areas* (where a *Flash Fire* could occur), and *Vapor Cloud Explosions*. Each is described on the following pages. Often, more than one kind of fire and/or explosion is possible. ALOHA helps you by listing the kinds of fires and explosions that are possible, given your release scenario.

Chemical releases involving a fire and/or an explosion can be complicated in that an initial incident may trigger other fires and explosions in the surrounding area. The trigger may be an increase in temperature, an open flame, or a container punctured by debris from the initial fire or explosion. Throughout this manual the term “fires and explosions” will be used to describe situations where there may be a combination or a series of fires and/or explosions.

## **Jet fires**

A jet fire, also referred to as a flame jet, occurs when a flammable chemical is rapidly released from an opening in a container and immediately catches on fire—much like the flame from a blowtorch. ALOHA can model a jet fire from the Gas Pipeline and Tank sources. For the Tank source, ALOHA can model gas and two-phase jet fires. A two-phase jet fire occurs when a gas that has been liquefied under pressure is released. Because the liquid evaporates as it escapes, the chemical is released as an aerosol spray—that is, a mixture of gas and tiny liquid droplets.

ALOHA assumes the jet fire release is oriented vertically, although the wind can tilt the flames in the downwind direction.

Thermal radiation is the primary hazard associated with a jet fire. Other potential jet fire hazards include smoke, toxic byproducts from the fire, and secondary fires and explosions in the surrounding area, although ALOHA does not model these hazards.

In some cases, heat from the jet fire may weaken the tank and cause it to fail completely—in which case, a BLEVE may occur. Typically, a BLEVE poses a greater threat than a jet fire. If the chemical inside the tank is likely to BLEVE (for example, if the tank contains a *liquefied gas*), in addition to modeling the scenario as a jet fire, you should also rerun the scenario as a BLEVE to compare the size of the threat zones.

## **Pool fire**

A pool fire occurs when a flammable liquid forms a puddle on the ground and catches on fire. ALOHA only models pool fires on land; it does not model pool fires on water. Thermal radiation is the primary hazard associated with a pool fire. Other potential pool fire hazards include smoke, toxic byproducts from the fire, and secondary fires and explosions in the surrounding area (although ALOHA does not model these hazards).

In some cases, heat from the pool fire may weaken a leaking tank and cause it to fail completely—in which case, a BLEVE may occur. Typically, a BLEVE poses a greater threat than a pool fire. If the chemical inside the tank is likely to BLEVE (for example, if the tank contains a liquefied gas), you may want to model the situation first as a pool fire and then rerun the scenario as a BLEVE to compare the size of the threat zones.



## **BLEVEs**

BLEVE stands for Boiling Liquid Expanding Vapor Explosion. BLEVEs typically occur in closed storage tanks that contain a liquefied gas, usually a gas that has been liquefied under pressure. A gas can be liquefied by either cooling (refrigerating) it to a temperature below its boiling point or by storing it at a high pressure. Although both flammable and nonflammable liquefied gases may be involved in a BLEVE, ALOHA only models flammable liquid BLEVEs.

Propane is an example of a chemical that has been involved in many BLEVE accidents. Most propane tanks at service stations contain liquid propane. These tanks are neither insulated nor refrigerated, so the tank contents are at ambient temperature. Since the ambient temperature is almost always significantly above propane's boiling point of  $-43.7^{\circ}\text{F}$ , the tanks are highly pressurized.

A common BLEVE scenario happens when a container of liquefied gas is heated by fire, increasing the pressure within the container until the tank ruptures and fails. When the container fails, the chemical is released in an explosion. If the chemical is above its boiling point when the container fails, some or all of the liquid will flash-boil—that is, instantaneously become a gas. If the chemical is flammable, a burning gas cloud called a *fireball* may occur if a significant amount of the chemical flash-boils. ALOHA assumes that any liquid not consumed in the fireball will form a pool fire.

ALOHA estimates the thermal radiation hazard from a fireball and/or a pool fire. Other potential BLEVE hazards include overpressure, hazardous fragments, smoke, and toxic byproducts from the fire (although ALOHA does not model these hazards). ALOHA focuses on the thermal radiation because in most BLEVEs thermal radiation impacts a greater area than the overpressure and is the more significant threat.

**Fireball.** When you model a BLEVE, ALOHA assumes that a fireball will form. The fireball is made up of both the chemical that flash-boils when the tank fails and the chemical that sprays out as an aerosol during the explosion. ALOHA estimates that the amount of chemical in the fireball is three times the amount of chemical that flash-boils. Any liquid that does not participate in the fireball will form a pool fire. When you choose to model a BLEVE situation in ALOHA, the program estimates the thermal radiation from both fires; it is not necessary to run an additional Pool Fire scenario. The primary hazard associated with a fireball is thermal radiation. However, if there are other chemicals near the fireball, it can trigger additional fires and explosions.

**Explosion and hazardous fragments.** In a BLEVE, a high-pressure explosion typically causes the container to fragment. As the container breaks apart, it may strike objects in the surrounding area and create additional debris. The container fragments and other debris—hazardous fragments—are swept up in the explosion and rapidly propelled by the explosion over a wide area. ALOHA does not model the dispersion of hazardous fragments or overpressure (blast force) in a BLEVE. If a BLEVE is likely to occur, first responders must take the necessary precautions to protect themselves and others from the overpressure and hazardous fragments.

## **Flash fires (flammable area)**

When a flammable vapor cloud encounters an ignition source, the cloud can catch fire and burn rapidly in what is called a flash fire. Potential hazards associated with a flash fire include thermal radiation, smoke, and toxic byproducts from the fire. ALOHA will predict the flammable area of the vapor cloud—that is, the area where a flash fire could occur at some time after the release. The flammable area is bounded by the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL). These limits are percentages that represent the concentration of the fuel—that is, the chemical—vapor in the air. If the chemical vapor comes into contact with an ignition source, it will burn only if its fuel-air concentration is between the LEL and the UEL, because that portion of the cloud is already pre-mixed to the right mixture of fuel and air for burning to occur.

If the fuel-air concentration is below the LEL, there is not enough fuel in the air to sustain a fire or an explosion—it is too lean. If the fuel-air concentration is above the UEL, there is not enough oxygen to sustain a fire or an explosion because there is too much fuel—it is too rich. (This is similar to an engine that cannot start because it has been flooded with gasoline.) If a flash fire occurs, the part of the cloud where the fuel-air concentration is above the UEL may continue to slowly burn as air mixes with the cloud.

### **Is there a difference between a Flammable Limit and an Explosive Limit?**

No, there is no difference. The two terms can be used interchangeably. Some people may prefer to use the terms Lower Flammable Limit (LFL) and Upper Flammable Limit (UFL), particularly if they are only concerned with fires.

You might expect that the LEL could be used as the LOC to determine the areas in which a fire might occur. However, the concentration levels estimated by ALOHA are time-averaged concentrations. In an actual vapor cloud, there will be areas where the concentration is higher than the average and areas where the concentration is lower than the average. This is called concentration patchiness. Because of concentration patchiness, there will be areas, called pockets, where the chemical is in the flammable range even though the average concentration has fallen below the LEL. (ALOHA uses a shorter averaging time when estimating the flammable areas, to help compensate for this effect, but it cannot completely compensate for this effect.) Some experiments have shown that flame pockets can occur in places where the average concentration is above 60% of the LEL. ALOHA uses 60% of the LEL as the default LOC for the red threat zone. Another common threat level used by responders is 10% of the LEL. ALOHA uses this concentration as the default LOC for the yellow threat zone.

## **Vapor cloud explosions**

When a flammable chemical is released into the atmosphere, it forms a vapor cloud that will disperse as it travels downwind. If the cloud encounters an ignition source, the parts of the cloud where the concentration is within the flammable range (between the LEL and UEL) will burn. The speed at which the flame front moves through the cloud determines whether it is a deflagration or a detonation (see next page). In some situations, the cloud will burn so fast that it creates an explosive force (blast wave). The severity of a vapor cloud explosion depends on the chemical, the cloud size at the time of ignition, the type of ignition, and the congestion level inside the cloud. The primary hazards are overpressure and hazardous fragments. ALOHA can help you model the overpressure hazard.

**Deflagration and detonation.** The destructive blast force of a vapor cloud explosion depends in part on how quickly the explosion spreads—that is, the rate at which its flame front travels. Once an explosion has been triggered, a flame front will spread through the flammable vapor cloud, igniting areas where the concentration is in the flammable range. The explosion produces a pressure wave that spreads out into the surrounding area, causing damage to people and property. The greater the speed of the flame front, the more intense the pressure wave (overpressure), and the greater the destructive force of the explosion.

For most accidental explosions, the flame front will travel relatively slowly in what is called a *deflagration*. For example, a typical deflagration flame front (for hydrocarbon combustions) travels about 2.2 miles per hour, or 1 meter per second (Lees 2001). For intentional explosions (and worst-case accidental explosions), the flame front travels rapidly in what is called a *detonation*. For example, a typical detonation flame front (for hydrocarbon combustions) travels about 5,600 miles per hour, or 2,500 meters per second (Lees 2001). In some situations, a deflagration flame front can accelerate into a detonation flame front. Accidental explosions that result in a high-speed deflagration or a detonation are more likely to occur in areas of high congestion and confinement.

**Congestion and confinement.** *Congestion* is a concept used to quantify the way small structures within the vapor cloud affect the severity of the explosion. Congestion refers to the density of obstacles that generate turbulence. Obstacles of this nature are generally small, like a shrub, and do not impede the flame front. Larger objects, like a building, can impede the flame front, so they should not be considered obstacles for the purposes of congestion. Greater turbulence allows the flame front to accelerate, thereby generating a more powerful blast wave (i.e., greater overpressure).

ALOHA uses two congestion levels: **congested** and **uncongested**. ALOHA's blast estimates are based on experiments that used a volume blockage ratio (volume occupied by obstacles within the cloud divided by cloud volume) of less than 1.5% for an uncongested cloud and greater than 1.5% for a congested cloud.

Estimating the level of congestion in a non-laboratory setting is difficult, but the following examples might be helpful. Uncongested zones include: parking lots, open fields, suburban neighborhoods, and most urban environments. Generally, a congested zone has so many closely spaced obstacles that it is difficult or impossible to walk through it. It is uncommon for this level of congestion to be found throughout the entire vapor cloud. However, pipe racks in industrial facilities and some forested areas (where the trees and branches are closely spaced) may be characterized as congested areas.

**What role does confinement play in vapor cloud explosions?**

Partial confinement can also increase the severity of the explosion. In general, a vapor cloud is considered partially confined when walls, ceilings, or other extended surfaces keep the cloud from moving freely. For example, an open-sided parking garage is a partially confined space. ALOHA does not model partially or completely confined vapor clouds.

## ALOHA's limitations

Like any model, ALOHA cannot be more accurate than the information you give it to work with, so it is important to enter the most accurate information. If you are unsure of a value, you should choose a value that would give the worst-case scenario or run multiple scenarios and compare the results. Consult the on-screen help or the Reference chapter if you are unsure of what choice to make. Additionally, ALOHA's models use atmospheric information to estimate the spread of the chemical release. If any of the atmospheric conditions (e.g., wind speed) change substantially during a response, you should correct the inputs and create a new threat zone plot because the old plot may no longer be accurate.

Even when you can provide accurate input information, ALOHA's results can be unreliable under some conditions and there are some effects that ALOHA doesn't model at all.

### Conditions that can produce unreliable results

ALOHA's results can be unreliable when the following conditions exist:

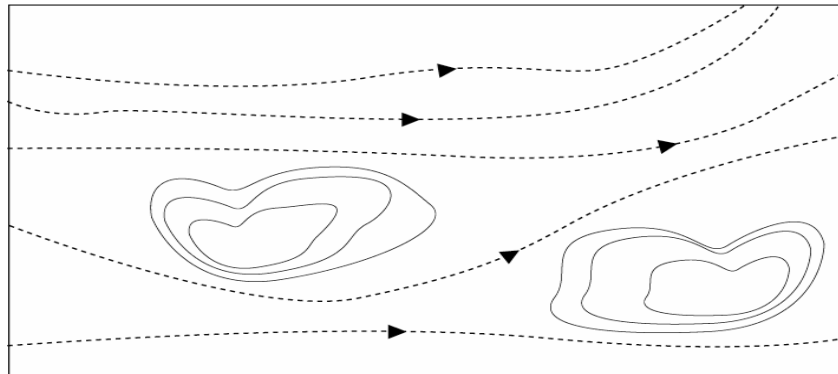
- Very low wind speeds;
- Very stable atmospheric conditions;
- Wind shifts and terrain steering effects; or
- Concentration patchiness, particularly near the release source.

**Very low wind speeds.** ALOHA's threat zones are accurate if the wind direction does not change from the value that you entered. Generally, wind direction is least predictable when wind speed is low. To show how much a dispersion threat zone's position could change if the wind were to shift direction, under the particular weather conditions that you enter, ALOHA draws two dashed lines, one along each side of the threat zone. ALOHA predicts that about 95 percent of the time, the wind will not shift direction enough to move the hazard outside of either line. The wider the zone between the lines, the less predictable is the wind direction and the more likely it is to change substantially. At the lowest wind speeds acceptable to ALOHA (about 2 knots, or 1 meter per second, at a height of 10 meters), these lines form a circle to indicate that the wind could blow from any direction.

**Very stable atmospheric conditions.** Under the most stable atmospheric conditions (most common late at night or very early in the morning), there is usually very little wind and almost no *mixing* of the released chemical with the surrounding air. Gas concentrations within the cloud can remain high far from the source. The accidental release of methyl isocyanate gas at Bhopal, India, in 1984 is an example of what can happen under very stable atmospheric conditions. Thousands of people died, including many who were far from the release. In a very stable atmosphere, a chemical cloud will spread out in the same manner as cream poured into a coffee cup. The cream will dilute and spread slowly into the coffee, but it will take a very long time to mix completely into the coffee without stirring it. Similarly, the cloud will spread slowly, and high gas concentrations may build up in small valleys or depressions and remain for long periods of time, even at distances far from the release point. ALOHA does not account for buildup of high gas concentrations in low-lying areas.

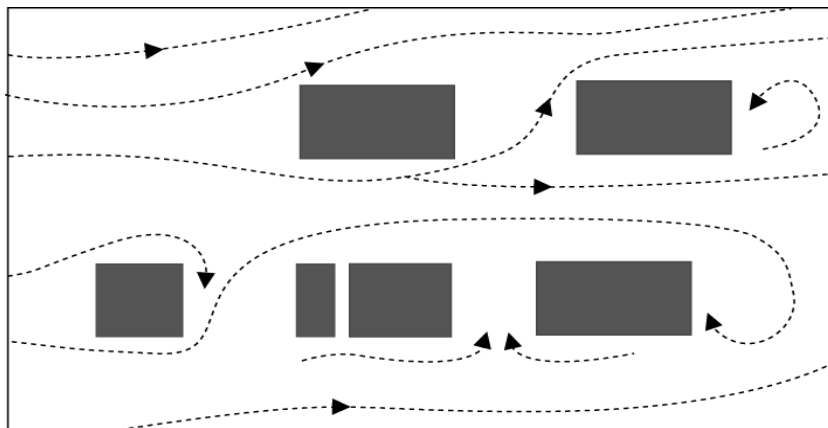
First responders should be aware that very stable atmospheric conditions create a dangerous situation in which models like ALOHA are not very reliable. In this situation, think about whether the chemical will behave as a heavy gas, and look for physical depressions and topographic features that may trap or steer the dispersing cloud.

**Wind shifts and terrain steering effects.** ALOHA allows you to enter only single values for wind speed and wind direction. It then assumes that wind speed and direction remain constant (at any given height) throughout the area downwind of a chemical release. ALOHA also expects the ground to be flat and free of obstacles. In reality, though, the wind typically shifts speed and direction as it flows up or down slopes, between hills or down into valleys, turning where terrain features turn. The way in which land features modify patterns of air flow is called *terrain steering* and it is shown in Figure 1-3.



**Figure 1-3.** Wind shifts from terrain steering.

In urban areas, wind flowing around large buildings forms eddies and changes direction and speed, significantly altering a cloud's shape and movement, as seen in Figure 1-4. Through streets bordered by large buildings can generate a *street canyon* wind pattern that constrains and funnels a dispersing cloud. ALOHA ignores these effects when it produces a threat zone plot; the threat zone will appear to go right over, or through, obstacles such as buildings. Consider the effects of terrain on wind flow whenever you are interpreting ALOHA results.



**Figure 1-4.** Small-scale variations in wind direction.

Because the wind is likely to shift in direction and change speed over both distance and time, limits have been placed on ALOHA's output. ALOHA will not make predictions for more than an hour after a release begins, or for distances more than 10 kilometers (6.2 miles) from the release point (it truncates threat zones that are longer than 10 kilometers). ALOHA's 1-hour time cutoff exists because wind shifts direction and changes speed frequently. One reason for the 10-kilometer cutoff for ALOHA threat zone length is that we don't know what the wind speed and direction are 10 kilometers away, and can't assume that they are the same as those at the point where a chemical is being released. If ALOHA has incorrect values for wind speed and direction, it can't correctly estimate threat zone size or location.

**Concentration patchiness.** No one can predict the gas concentration at any particular instant downwind of a release with certainty, because they result partly from random chance. Instead, ALOHA shows you concentration values that represent averages for time periods of several minutes (it uses the laws of probability as well as meteorologists' knowledge of the atmosphere to do this). ALOHA predicts that average concentrations will be highest near the release point and along the centerline of any pollutant cloud, and will drop off smoothly and gradually in the downwind and crosswind directions. However, especially near the source of a release, wind eddies push a cloud unpredictably about, causing gas concentrations at any moment to be high in one location and low in another. This kind of movement is familiar to anyone who has tried to toast marshmallows over a campfire like the one in Figure 1-5 (no matter where you sit, the smoke from the fire always seems to come straight towards you). Meanwhile, the average concentrations are likely to behave approximately as ALOHA predicts. As the cloud moves downwind from the release point, these eddies shift and spread the cloud, evening out concentrations within the cloud so that they become more similar to ALOHA's predictions.



**Figure 1-5.** Concentration patchiness close to the source.

## Effects that are not modeled

ALOHA doesn't account for the effects of:

- Byproducts from fires, explosions, or chemical reactions;
- Particulates;
- Chemical mixtures;
- Terrain; and
- Hazardous fragments.

**Byproducts from fires, explosions, or chemical reactions.** ALOHA doesn't account for the byproducts of combustion (e.g., smoke) or for chemical reactions. ALOHA assumes that a dispersing chemical cloud does not react with the gases that make up the atmosphere, such as oxygen and water vapor. However, many chemicals react with dry or humid air, water, other chemicals, or even themselves.

Because of these chemical reactions, the chemical that disperses downwind might be very different from the chemical that originally escaped from containment. In some cases, this difference may be substantial enough to make ALOHA's dispersion predictions inaccurate. For example, if aluminum phosphide escapes from containment and comes in contact with water, the reaction between the water and aluminum phosphide produces phosphine gas. It is the phosphine, rather than the aluminum phosphide, that escapes into the atmosphere. If you respond to such an accident, and wish to use ALOHA to obtain a threat zone estimate, you need to estimate how rapidly phosphine is being generated from the reaction between water and aluminum phosphide, and you need to model the incident in ALOHA as a release of phosphine, rather than aluminum phosphide.

**Particulates.** ALOHA does not account for the processes that affect dispersion of particulates (including radioactive particles).

**Chemical mixtures.** ALOHA is designed to model the release of pure chemicals and some chemical *solutions*. It's difficult for any model to correctly predict the behavior of a solution or a mixture of chemicals because it's difficult to accurately predict chemical properties such as vapor pressure for solutions or mixtures. ALOHA's predictions are greatly affected by this and other chemical properties. When an incorrect property value is used in ALOHA, the model's release rate and dispersion estimates will not be valid.

**Terrain.** ALOHA expects the ground below a leaking tank or puddle to be flat, so that the liquid spreads out evenly in all directions. It does not account for pooling within depressions or the flow of liquid across sloping ground.

**Hazardous fragments.** If a chemical release involves an explosion, there will be flying debris from the container and the surrounding area. ALOHA does not model the trajectories of the hazardous fragments.

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# Installing ALOHA

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This chapter describes how to install ALOHA on a computer running Microsoft Windows or on a Macintosh computer.

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## Before you install ALOHA

### Memory and hard disk space requirements

**In Windows.** ALOHA runs in Microsoft Windows. It requires about 2.5 megabytes of space on your hard drive.

**On a Macintosh.** ALOHA runs on Macintosh under Systems 7, 8, and 9. In System OS X, ALOHA will run under Classic. It requires about 2.5 megabytes of space on your hard drive.

### If you already have a previous version of ALOHA

If you already have a version of ALOHA installed on your computer, the ALOHA Installer will update your existing ALOHA files as follows:

- It will not overwrite the ALOHA location library (CityLib.lib). Any location information you have added will be retained.
- It will replace your out-of-date chemical library (ChemLib) with the current version. Any chemical information you have added to the library will not be saved. You will need to re-enter that information into the new library after you have installed ALOHA. You will not be able to open a previous version of the chemical library using the current version of ALOHA, so before you install ALOHA be sure that you have a record—in some other form—of the information you have added to the library.

Whether or not you have a previous version of ALOHA installed on your computer, follow the instructions on the next page to install the current version.



## Installing ALOHA in Windows

To obtain the latest version of ALOHA, go to the following Web site: <http://www.epa.gov/ceppo/cameo/>. Click on **Request CAMEO**. The **EPA Get CAMEO** page appears. Under **Download CAMEO**, scroll down and click on **ALOHA Download Page**. Under **Downloading the Program**, click on **Download ALOHA for Windows**. Follow the directions and save the **aloha.exe** file on your hard drive.

### Making the installation

1. Exit all Windows programs before beginning the installation.
2. Double click on the **ALOHA Installer**.
3. Follow the instructions on your screen to install ALOHA.

To run ALOHA, open the **Start** menu, point to **Programs**, then click on the **ALOHA icon**.

## Installing ALOHA on a Macintosh

To obtain the latest version of ALOHA, go to the following Web site: <http://www.epa.gov/ceppo/cameo/>. Click on **Request CAMEO**. The **EPA Get CAMEO** page appears. Under **Download CAMEO**, scroll down and click on **ALOHA Download Page**. Under **Downloading the Program**, click on **Download ALOHA for Macintosh**. Follow the directions and save the **alohains.sit.hqx** file on your desktop.

### Making the installation

1. If the **alohains.sit.hqx** file does not automatically expand to produce the ALOHA Installer, then double-click on the **alohains.sit.hqx** file on the desktop—this will expand the **.hqx** file and produce the ALOHA Installer on the desktop. (StuffIt Expander should be part of both System 9 and 10. If your Macintosh computer does not have StuffIt Expander, you can download a free copy at the following Web site: <http://www.stuffit.com/mac/expander/>).
2. Double-click the **ALOHA Installer** program icon.
3. Read the introductory information, then click **Install** to install ALOHA on your hard drive.

If you already have a previous version of ALOHA, your ALOHA files will be placed either in your existing ALOHA Folder or in a new ALOHA Folder on the top level of your hard drive (or startup volume, if you have more than one hard drive). The ALOHA Folder will contain **ALOHA** (the main program), **AlohaLib** (a folder that contains CityLib and ChemLib), and **ALOHA.prf** (a file that contains specific preference information. If you also are installing CAMEO on your computer, we recommend that you place the ALOHA Folder inside your CAMEO Folder. You can move the ALOHA Folder to any location on your hard drive, but don't remove any ALOHA files from this folder.

To run ALOHA, open the **ALOHA Folder** and double-click on the **ALOHA icon**.

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# Learning the Basics

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This chapter contains a step-by-step ALOHA example—a toxic gas dispersion scenario describing a chlorine release at a fictional treatment plant in South Dakota. Follow along, using your own copy of ALOHA, in order to familiarize yourself with its menus and features. For more information about any aspect of ALOHA, go to the Reference chapter.

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## Guided tour

The Central Water Facility treatment plant is located in a rural area about 2 miles from Sioux Falls, South Dakota. The plant uses 1-ton containers of chlorine in the water treatment process (these tanks are 2.5 feet in diameter and 6.8 feet long). The highest-risk operation at the plant is the changing of chlorine tanks. This operation is done only during daytime hours. At 2:30 p.m. on June 25, 2006, while being moved into the building, a single container begins to leak through a valve located in the center of one end (this valve is one-half inch in diameter). The tank contains one ton of chlorine when it begins to leak.

### Fire and explosion scenarios

This tutorial chapter will give you a solid understanding of how to move through the ALOHA menus and enter scenario information. However, this tutorial only goes through a toxic gas dispersion scenario. If you plan on using ALOHA to run fire and explosion scenarios, you should also review the fire and explosion scenarios in the Examples chapter.

Local meteorologists at NOAA's National Weather Service Weather Forecast Office have provided the weather conditions at Sioux Falls. These conditions are: a wind speed of 5 miles per hour from the south (measured at a height of 10 meters), sky three-tenths covered, air temperature of 72°F, and 50 percent relative humidity. There is no low-level inversion.

You'll use ALOHA to assess the potential hazard by estimating:

- The *threat zones*, representing the areas downwind of the release that may be at risk; and
- The predicted chlorine concentrations at the Central Valley Elementary School, located about 1,500 yards downwind of the treatment plant. In ALOHA, this feature is called the *Threat at Point*.

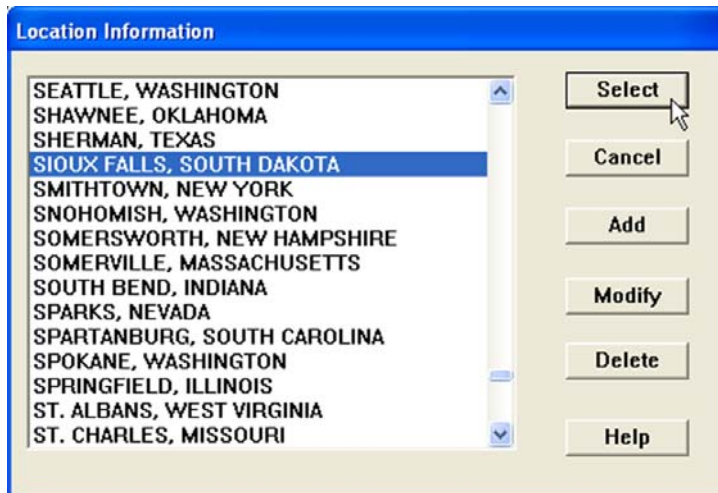
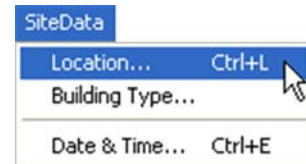
### Using on-screen ALOHA help

As you use ALOHA, you'll enter information on a series of dialog boxes to describe your scenario. On most dialog boxes, you'll see at least one Help button, which you can use to access on-screen help. Click any of these buttons at any time to view an explanation of the ALOHA feature you're using or input value that you must enter into the model. To return to the dialog box once you've finished reading the help information: a) with Microsoft Windows, close or minimize the Help window or, b) on a Macintosh, click Cancel to exit from the on-screen help.

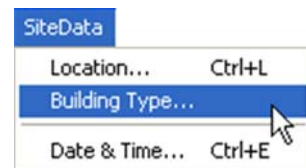
## Describing the time and place

Your first tasks are to start ALOHA, and then describe the time and place of the scenario.

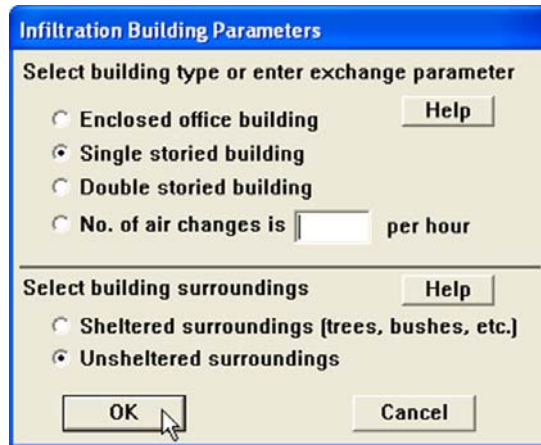
1. Start ALOHA. (In Windows, click the **Start** button, point to **Programs**, then choose the **ALOHA** item. On a Macintosh, double-click the **ALOHA** program icon located in the **ALOHA Folder**.)
2. Read the list of ALOHA's limitations (click **Help** to see more details), then click **OK**.
3. Select **Location** from the **SiteData** menu. A Location Information dialog box appears with a list of the names of cities included in ALOHA's location library.
4. The treatment plant is located 2 miles from Sioux Falls, South Dakota. Type the characters "si" to quickly move to SIOUX FALLS, SOUTH DAKOTA. Check to be sure that this name is highlighted, then click **Select**.



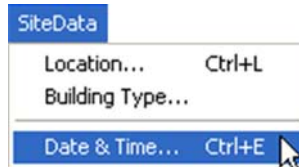
5. Central Valley Elementary School is located about 1,500 yards downwind of the treatment plant. ALOHA uses information about building type, along with other information such as wind speed and air temperature, to determine indoor infiltration rate and to estimate indoor concentration at a location of concern. (To estimate infiltration rate into a building, ALOHA assumes that all doors and windows are closed.) Choose **Building Type** from the **SiteData** menu. An Infiltration Building Parameters dialog box appears.



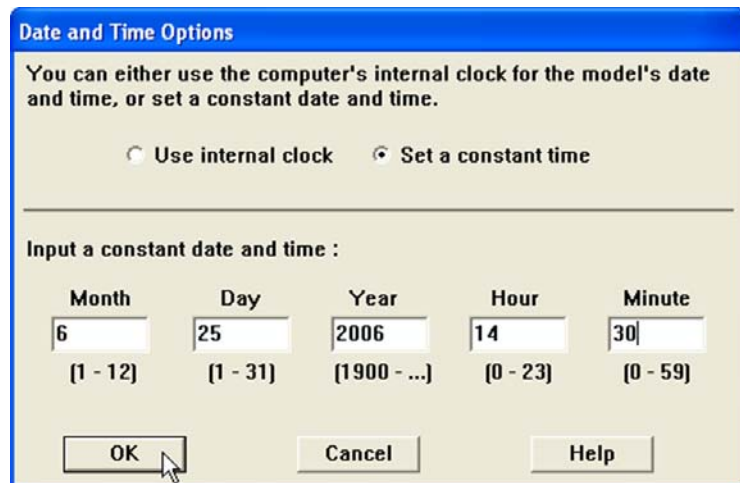
- The school is a single-storied building, surrounded mostly by open fields. Check to be sure that **Single storied building** and **Unsheltered surroundings** are selected. Click **OK**.



- Select **Date & Time** from the **SiteData** menu. A Date and Time Options dialog box appears.



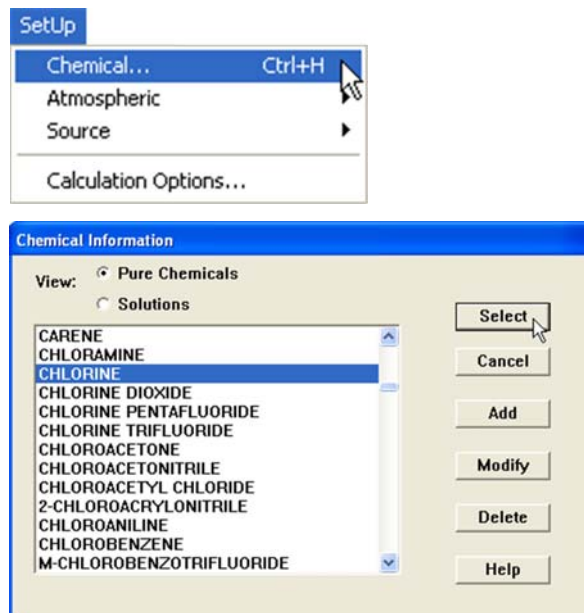
- The release occurs on June 25, 2006 at 2:30 p.m. (ALOHA requires time of day in 24-hour time). Select the **Set a constant time** option. Type "6" in the Month box, "25" in the Day box, and "2006" in the Year box. Type "14" in the Hour box and "30" in the Minute box (click Help to learn how to convert a time value to 24-hour time). Click **OK**.



## Choosing a chemical

As you build your ALOHA scenario, your next task is to choose the chemical that is being released (chlorine).

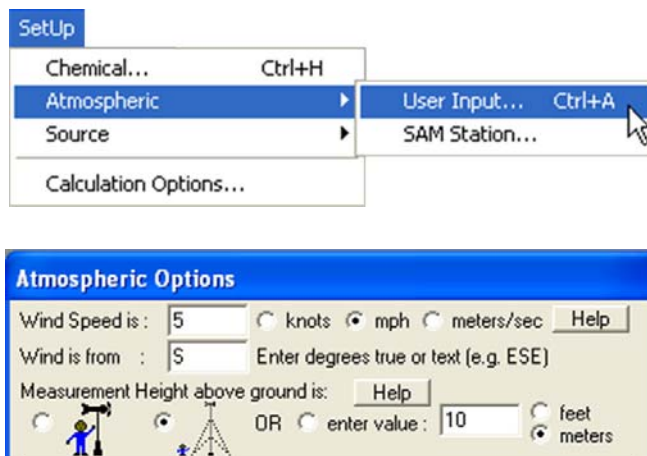
1. To choose chlorine, select **Chemical** from the **SetUp** menu. A Chemical Information dialog box appears with a list of the chemicals in ALOHA's chemical library.
2. Select **Pure Chemicals** at the top of the window (this should be the default). Find **CHLORINE** in the list (quickly type the characters "ch" to locate chlorine more rapidly in the list), click on this name, then click **Select**.



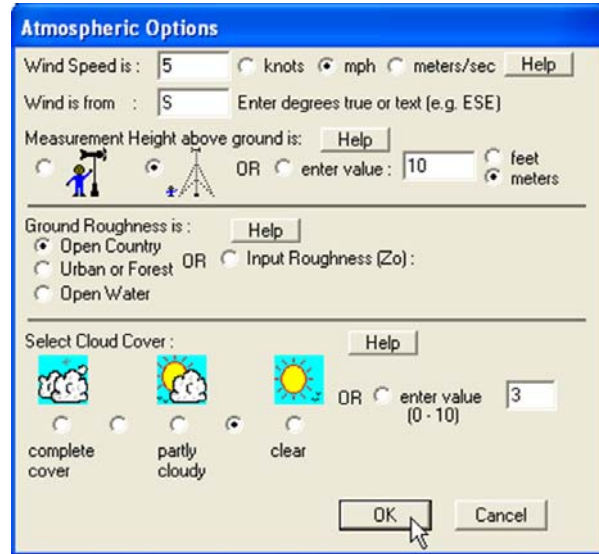
## Describing the weather

When entering weather information in ALOHA, you must choose whether you are going to enter weather information manually or from a portable monitoring—or SAM—station. In this example, you'll enter information manually.

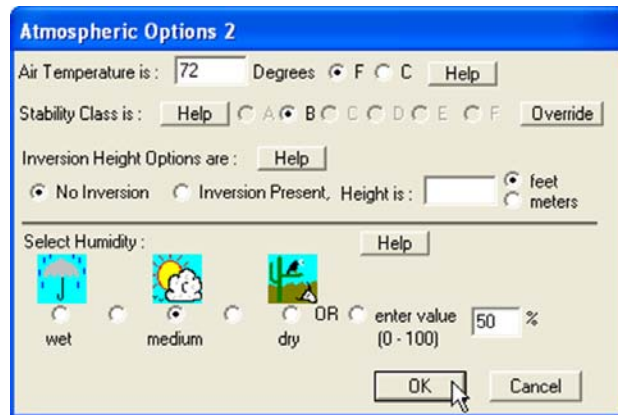
1. In the **SetUp** menu, point to **Atmospheric**, then select **User Input**. The first Atmospheric Options dialog box appears.
2. The wind is travelling from the south at a speed of 5 miles per hour (mph). Type "5" in the wind speed box, then select **mph**. Type "S" in the wind direction box.
3. The wind conditions were measured at a height of 10 meters (this is the height at which the National Weather Service usually takes measurements). Select the **tower icon** in the Measurement Height section. Notice that ALOHA has filled in a value of 10 meters.



4. The exact ground roughness (a measure of the unevenness, or roughness, of the terrain over which the gas cloud passes) is not known, but the accident occurs in a rural farming area—open fields with few trees and buildings. (In ALOHA, ground roughness can be entered explicitly—if the exact roughness number is known—or implicitly by choosing a representative type of terrain.) Select the **Open Country** ground roughness option.
5. About 3 tenths of the sky is covered by clouds. Under Select Cloud Cover, choose the fourth option from the left (the option between the partly cloudy and clear options). Notice that ALOHA has filled in a value of 3. Click **OK**. The second Atmospheric Options dialog box appears.



6. The air temperature is 72°F. Type “72” in the air temperature box, then select **F**.
7. ALOHA uses the wind speed, cloud cover, and date and time information that you’ve entered to automatically select atmospheric Stability Class B. (Stability is a measure of the amount of turbulence in the atmosphere; the more turbulent the air, the more quickly a pollutant cloud is diluted; B is a relatively less stable—that is, more turbulent—stability class.)
8. There is no low-level inversion. Check to be sure that **No inversion** is selected.
9. The relative humidity is about 50 percent. Select the icon for **medium** humidity. Notice that ALOHA has filled in a value of 50 percent. Click **OK**.



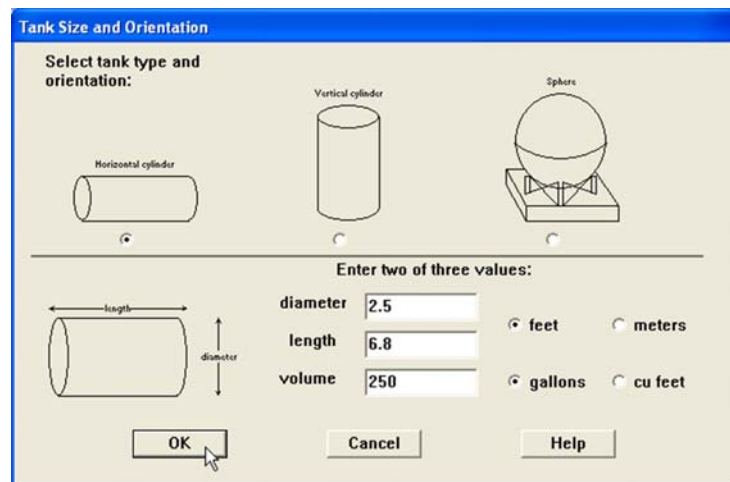
## Describing the release

Now you're ready to enter information about the release itself—that is, to “set the source”—for this scenario.

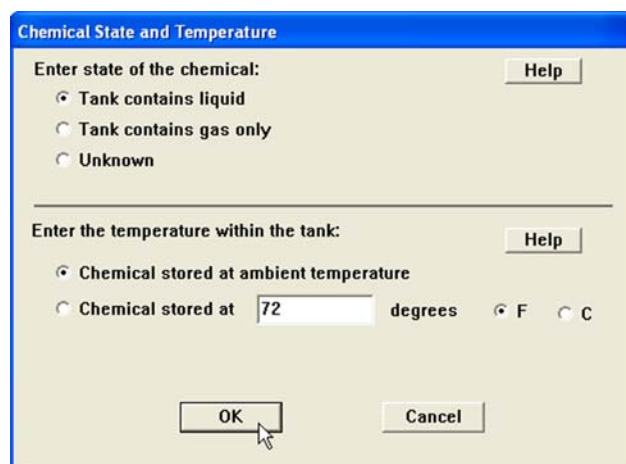
1. The chlorine at the treatment plant is stored in tanks. In the **SetUp** menu, point to **Source**, then select **Tank**. A Tank Size and Orientation dialog box appears.



2. The chlorine is stored in horizontal, standard 1-ton containers that are 2.5 feet in diameter and 6.8 feet long. Select **Horizontal cylinder**. Type “2.5” in the diameter box, then select **feet**. Type “6.8” in the length box. Notice that ALOHA automatically calculates the tank volume. Click **OK**. A Chemical State and Temperature dialog box appears.



3. Chlorine is a gas at ambient temperatures, but it is being stored under pressure as a liquefied gas at ambient temperature (the tank is not refrigerated in this scenario). Select the **Tank contains liquid** option. Check to be sure that **Chemical stored at ambient temperature** is selected. Click **OK**. A Liquid Mass or Volume dialog box appears.

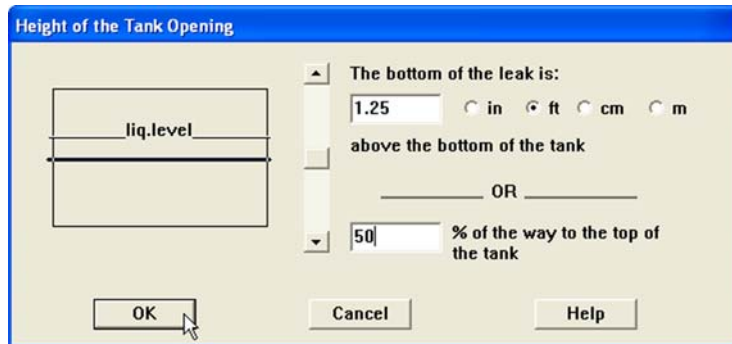


- The tank contains 1 ton (2,000 lbs) of chlorine. Select **tons (2,000 lbs)**, then type “1” in the mass in tank box. Notice that ALOHA fills in the other values. Click **OK**. An Area and Type of Leak dialog box appears.

- The chlorine is leaking from a half-inch diameter valve. Check to be sure that **Circular opening** is selected. Type “0.5” in the opening diameter box and select **inches**. Choose the **Short pipe/valve** option. Click **OK**. A Height of the Tank Opening dialog box appears.

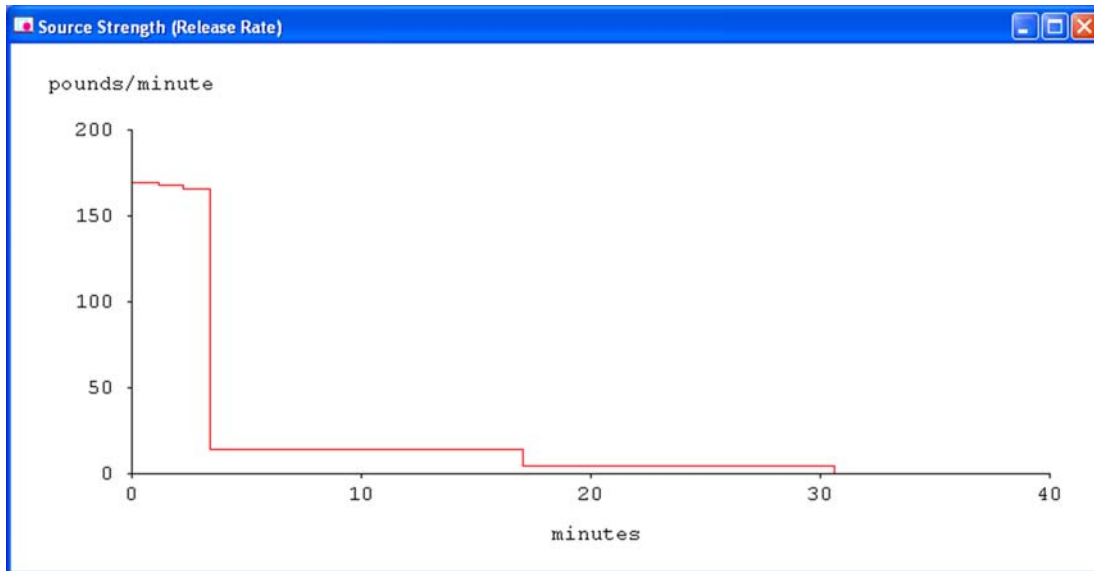


- The leaking valve is located at the center of one end of the tank. Type “50” in the percent of the way to the top of the tank box. Notice that ALOHA fills in the other values. Click **OK**.



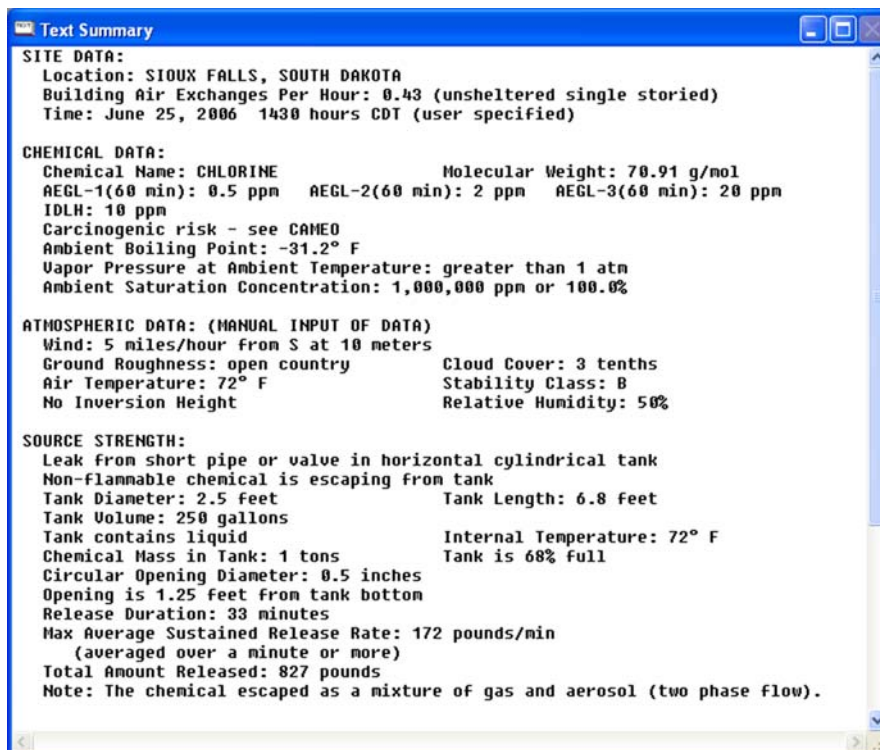
ALOHA then calculates the rate of release of chlorine from the tank, the duration of the release, and the total amount released. You’ll see these calculation results in the **Text Summary** window and in the source strength graph.

- Choose **Source Strength** from the **Display** menu to see the source strength graph for this scenario. The graph shows the predicted averaged release rate during the hour after the release begins.



On the graph, time since the release started (from 0 to 40 minutes) is shown on the horizontal axis (minutes), and release rate is shown on the vertical axis (pounds/minute). You can see from this graph that because the chlorine is escaping from a pressurized container, ALOHA predicts that release rate starts out high, then declines as container pressure drops. The highest step on this graph is the Maximum Averaged Sustained Release Rate.

In the Text Summary, under the Source Strength heading, you can see the estimated Maximum Average Sustained Release Rate. ALOHA predicts release rate from a puddle, tank, or gas pipeline as a series of hundreds of brief timesteps. ALOHA then averages this series of many release rates into between one and five release rates, each averaged over a time period of at least 1 minute. The Maximum Average Sustained Release Rate is the highest of these averaged release rates. To save calculation time, ALOHA uses only the averaged release rate(s) to make its threat zone estimates.



```
Text Summary
SITE DATA:
Location: SIOUX FALLS, SOUTH DAKOTA
Building Air Exchanges Per Hour: 0.43 (unsheltered single storied)
Time: June 25, 2006 1430 hours CDT (user specified)

CHEMICAL DATA:
Chemical Name: CHLORINE                      Molecular Weight: 70.91 g/mol
AEGL-1(60 min): 0.5 ppm  AEGL-2(60 min): 2 ppm  AEGL-3(60 min): 20 ppm
IDLH: 10 ppm
Carcinogenic risk - see CAMEO
Ambient Boiling Point: -31.2° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 5 miles/hour From S at 10 meters
Ground Roughness: open country                Cloud Cover: 3 tenths
Air Temperature: 72° F                        Stability Class: B
No Inversion Height                           Relative Humidity: 50%

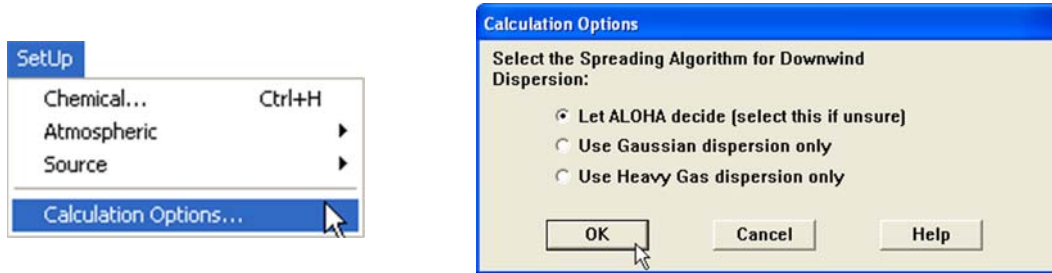
SOURCE STRENGTH:
Leak from short pipe or valve in horizontal cylindrical tank
Non-flammable chemical is escaping from tank
Tank Diameter: 2.5 feet                       Tank Length: 6.8 feet
Tank Volume: 250 gallons
Tank contains liquid                          Internal Temperature: 72° F
Chemical Mass in Tank: 1 tons                  Tank is 68% full
Circular Opening Diameter: 0.5 inches
Opening is 1.25 feet from tank bottom
Release Duration: 33 minutes
Max Average Sustained Release Rate: 172 pounds/min
(averaged over a minute or more)
Total Amount Released: 827 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).
```

The Text Summary window is like a blackboard: you can check its contents at any time to verify that you've entered correct values into ALOHA, or to review ALOHA's results. If your Text Summary window doesn't look like the one above, revise any incorrect information by choosing the appropriate menu item, then modifying the information that you entered. For example, if you indicated that the building is sheltered rather than unsheltered, choose **Building Type** from the **SiteData** menu again, click **Unsheltered surroundings**, then click **OK**. When you are sure that the Text Summary information is correct, you're ready to move on to the next steps.

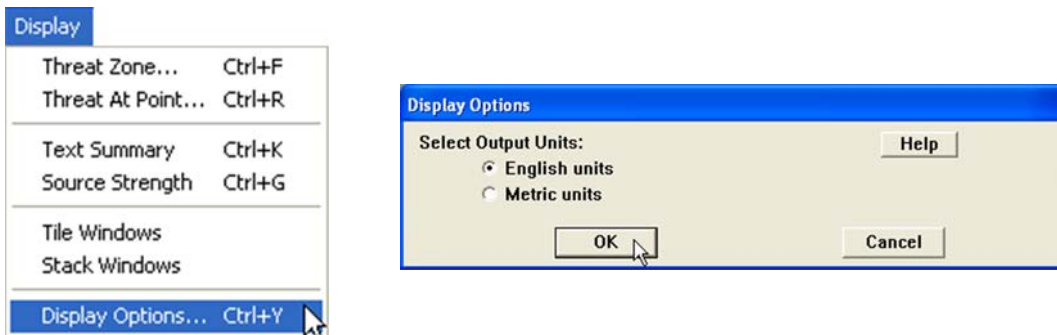
## Checking the Calculation and Display Options settings

Unless you specifically change its default setting, ALOHA uses information about the properties of the chemical and the amount of chemical released to choose whether to make Gaussian or heavy gas dispersion computations. Check to be sure that ALOHA is set to this default.

1. Select **Calculation Options** from the **SetUp** menu. A Calculation Options dialog box appears.
2. Check to be sure that **Let ALOHA decide (select this if unsure)** is selected. Click **OK**.



3. Select **Display Options** from the **Display** menu. A Display Options dialog box appears. Select **English units** and ALOHA's computation results will be displayed in those units. (When running ALOHA, you can choose either type of units, but for this example English units have been selected.) Click **OK**.



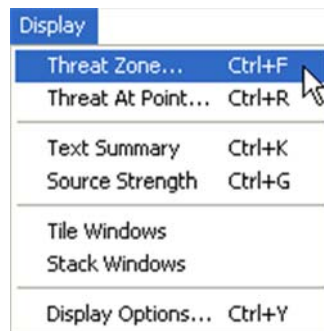
## Creating a threat zone plot

To obtain a threat zone estimate, you must first choose at least one *Level of Concern (LOC)*. (ALOHA allows you to choose up to three LOCs for a single scenario.) For toxic gas dispersion scenarios like this one, an LOC is a threshold concentration of the gas—usually the concentration above which a hazard is believed to exist. For each LOC you choose, ALOHA estimates the region, or threat zone, where the ground-level pollutant concentration may exceed your chosen level at some time after a release begins. ALOHA superimposes those threat zones estimates and displays them on a single composite threat zone plot—each threat zone is shown in a different color. The red threat zone represents the worst hazard and the orange and yellow threat zones represent areas of decreasing hazard.

### Choosing an LOC

No LOC represents an exact line between hazardous and non-hazardous conditions, because people differ in their sensitivity to chemicals (for example, old, sick, or very young people may be more sensitive to chemicals than healthy adults) and other hazards. An LOC that's appropriate for one person may be too high for somebody else. When you use an LOC in ALOHA, familiarize yourself with its definition, to be sure it's appropriate for the work that you're doing and the population that you're concerned about. Treat ALOHA's threat zone as a rough estimate of the true hazard zone for a chemical release.

1. Choose **Threat Zone** from the **Display** menu. A Toxic Level of Concern dialog box appears.



2. Decide which LOC values you want ALOHA to use to define the threat zones. For this example, you'll keep the default LOCs for chlorine—the Acute Exposure Guideline Levels (AEGLs). **Note: the AEGL level increases with increasing hazard. Therefore, ALOHA uses AEGL-3 for the red threat zone.** Many other toxic thresholds besides AEGLs exist. Click the **Help** button on the Toxic Level of Concern dialog box to learn more about choosing an LOC.

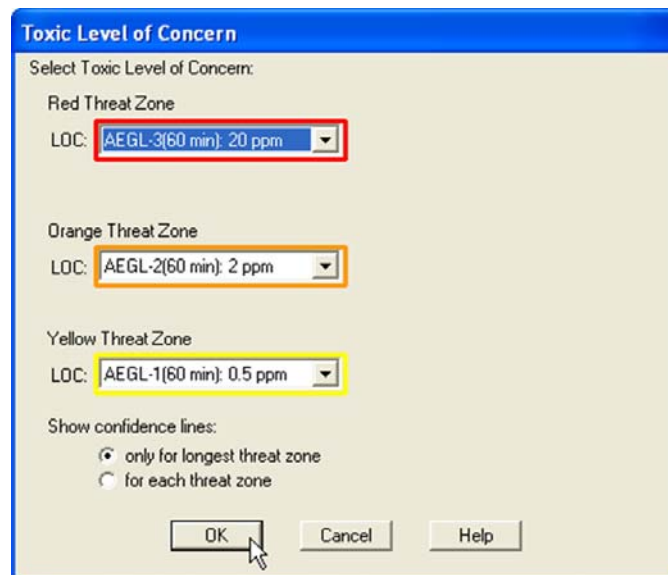
**What do the AEGL levels represent?**

**AEGL-1:** The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

**AEGL-2:** The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

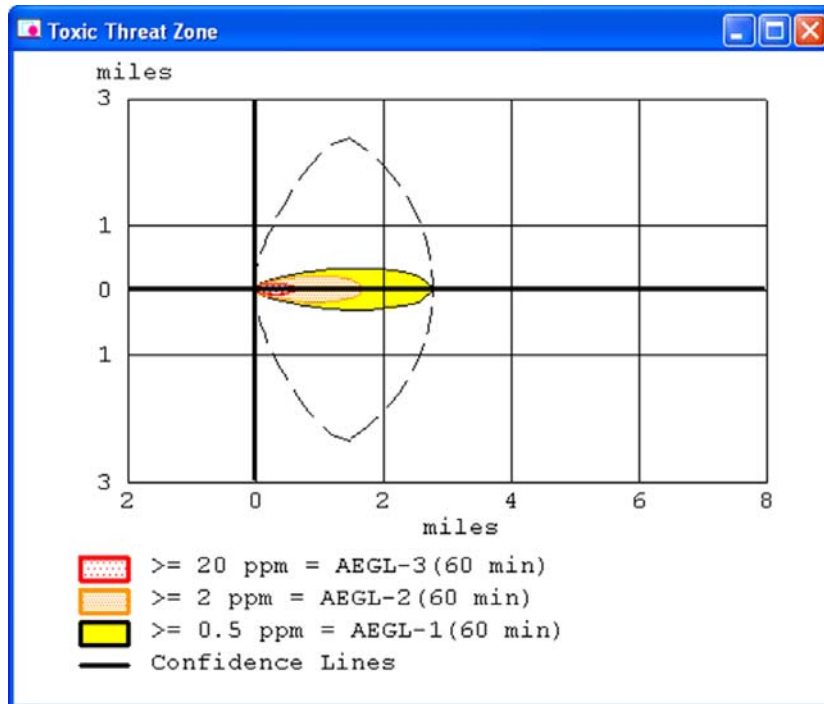
**AEGL-3:** The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Each of the three levels of AEGL—AEGL-1, AEGL-2, and AEGL-3—are established for each of five exposure periods: 10 minutes, 30 minutes, 60 minutes, 4 hours, and 8 hours. **Note: In ALOHA, the 60-minute AEGL exposure limits are the default toxic LOCs (when available).**



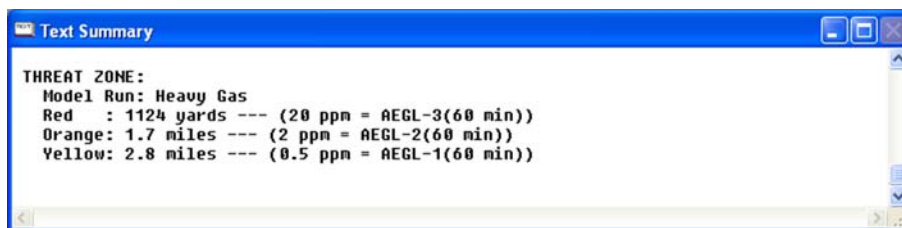
3. In the “Show confidence lines” section, check to be sure that **only for the longest threat zone** option is selected. Click **OK**. A Toxic Threat Zone window appears.

4. Examine ALOHA's threat zone plot for this scenario. On the plot, the red, orange, and yellow regions represent the areas where chlorine concentrations are predicted to exceed the corresponding LOC values (in this case, the AEGL values) at some time after the release begins. The red AEGL-3 threat zone—the area with the greatest exposure level—is predicted to extend more than half a mile downwind of the leaking cylinder. The orange AEGL-2 threat zone is predicted to extend more than one and a half miles downwind and the yellow AEGL-1 threat zone is predicted to extend for more than two miles.



Dashed lines along both sides of the yellow threat zone indicate uncertainty in the wind direction. The wind rarely blows constantly from any one direction. Each time it shifts direction, it blows a pollutant cloud in a new direction. The “uncertainty lines” around the longest threat zone enclose the region within which, about 95 percent of the time, the gas cloud is expected to remain.

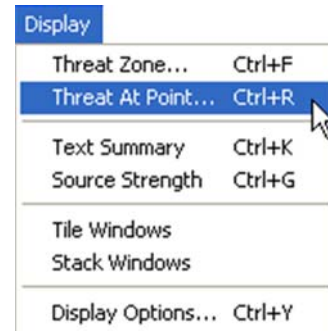
5. Review the Text Summary. You'll see the line of text, **Model Run: Heavy Gas**, informing you that ALOHA used the heavy gas model to make its threat zone estimate. Because the initial cloud of chlorine is heavier than air, ALOHA models it as a heavy gas rather than as a gas that is about the same weight as air.



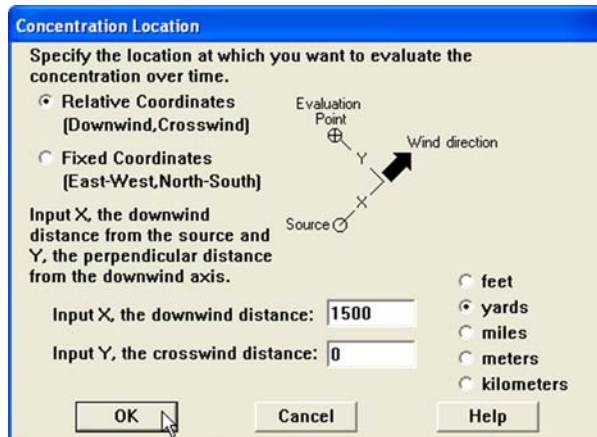
## Determining threat levels at a specific location

You can use ALOHA not only to estimate the extent of the area that could be at risk in an incident (that's the threat zone), but also to obtain predicted indoor and outdoor concentrations at any location of special concern during the hour after a release begins (that's the threat at a point).

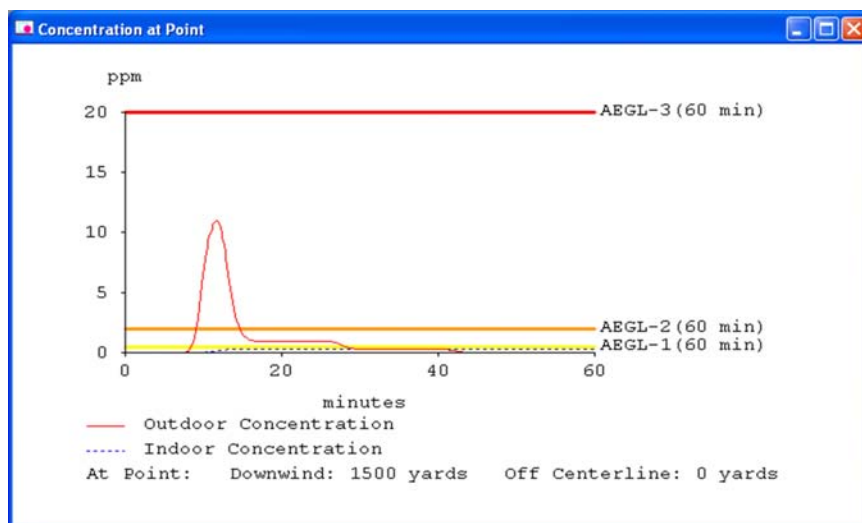
The Central Valley Elementary School is located about 1,500 yards downwind of the treatment plant. You have already indicated the school's building type and degree of shelter from the wind. Next, you'll indicate the location of the school relative to the release point at the treatment plant.



1. Choose **Threat At Point** from the **Display** menu. A Concentration Location dialog box appears.
2. Click **Relative Coordinates**, to indicate that you are describing the school's location in terms of its downwind and crosswind distance relative to the release point. (In other situations, you might choose to describe the school's location in terms of geographic—east-west or north-south—distances.) Type "1500" in the downwind distance box, then select **yards**. Type "0" in the crosswind distance box. (When you enter a crosswind distance of "0," you're indicating that the wind is blowing the gas cloud directly towards the location of concern, so that concentrations will be as high as possible. ALOHA's concentration graph then represents the worst-case prediction for the location.) Click **OK**.



ALOHA then displays a graph of predicted chlorine concentrations at the school during the hour after the release begins. The horizontal axis of this graph represents time (from 0 to 60 minutes after the release starts), and the vertical axis represents concentration at the location expressed in parts per million (ppm). The solid, thin red line represents the predicted outdoor, ground-level concentration. The dashed blue line represents predicted concentration inside a building of the type you selected using the **Building Type** menu item in the **SiteData** menu. To draw this line, ALOHA assumes that the building's doors and windows are closed and that its ventilation system is off. The horizontal red, orange, and yellow lines represent the LOCs (in this case, AEGL-3, AEGL-2, and AEGL-1, respectively).



ALOHA predicts that the cloud of chlorine would arrive at the school in about 7 minutes (that's when the outdoor concentration line begins to rise steeply on the graph), under the conditions of this scenario. Notice that the indoor concentration is predicted to remain much lower than the outdoor concentration, as long as the school's door and windows are closed. You also can see that ALOHA predicts that outdoor concentration would exceed one LOC (AEGL-2) for this scenario only briefly, but will exceed a lower LOC (AEGL-1) for much longer.

The indoor concentration does not exceed any of the LOC values; however, it does approach the AEGL-1 LOC for a significant period of time. At this level, people inside the building may begin to experience notable discomfort, irritation, or other temporary effects. Bear in mind that no LOC represents an exact line between hazardous and non-hazardous conditions, because people differ in their sensitivity to chemicals (for example, old, sick, or very young people may be more sensitive to chemicals than healthy adults) and other hazards. People who are more sensitive to the chemicals may experience more serious health effects than those predicted for the AEGL-1 level, even though that level was not exceeded in the hour after the release.

When you use ALOHA in planning or response, you may wish to compare predicted concentrations with other toxic thresholds besides AEGLs. Be sure that the LOCs that you choose reflect the hazard that you are concerned about, and are conservative enough for the uses to which you're putting your ALOHA results. (You make a conservative choice when the option is more likely to produce an overestimate of the hazard rather than an underestimate.)



Here's how the Text Summary window should look, now that you have completed your work with this example scenario (note that depending on the type of computer you use, some of the numbers that you see on your screen may be slightly different than those in the following figure):

```

Text Summary
SITE DATA:
Location: SIOUX FALLS, SOUTH DAKOTA
Building Air Exchanges Per Hour: 0.43 (unsheltered single storied)
Time: June 25, 2006 1430 hours CDT (user specified)

CHEMICAL DATA:
Chemical Name: CHLORINE Molecular Weight: 70.91 g/mol
AEGL-1(60 min): 0.5 ppm AEGL-2(60 min): 2 ppm AEGL-3(60 min): 20 ppm
IDLH: 10 ppm
Carcinogenic risk - see CAMEO
Ambient Boiling Point: -31.2° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 5 miles/hour from S at 10 meters Cloud Cover: 3 tenths
Ground Roughness: open country Stability Class: B
Air Temperature: 72° F Relative Humidity: 50%
No Inversion Height

SOURCE STRENGTH:
Leak from short pipe or valve in horizontal cylindrical tank
Non-flammable chemical is escaping from tank
Tank Diameter: 2.5 feet Tank Length: 6.8 feet
Tank Volume: 250 gallons
Tank contains liquid Internal Temperature: 72° F
Chemical Mass in Tank: 1 tons Tank is 68% full
Circular Opening Diameter: 0.5 inches
Opening is 1.25 feet from tank bottom
Release Duration: 33 minutes
Max Average Sustained Release Rate: 172 pounds/min
(averaged over a minute or more)
Total Amount Released: 827 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
Model Run: Heavy Gas
Red : 1124 yards --- (20 ppm = AEGL-3(60 min))
Orange: 1.7 miles --- (2 ppm = AEGL-2(60 min))
Yellow: 2.8 miles --- (0.5 ppm = AEGL-1(60 min))

THREAT AT POINT:
Concentration Estimates at the point:
Downwind: 1500 yards Off Centerline: 0 yards
Max Concentration:
Outdoor: 10.9 ppm
Indoor: 0.342 ppm

```

## Exiting (Quitting) ALOHA

When you've completed your work with ALOHA, just choose **Exit** from the **File** menu if you're using Windows, or **Quit** from the **File** menu if you're using a Macintosh. (You can also first save any ALOHA scenario as a file you can reopen later in ALOHA; check the section of the Reference chapter describing the **File** menu to learn how to do this).

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# Examples

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This chapter contains three step-by-step ALOHA example scenarios. You can complete the first two scenarios using only ALOHA. To complete the third scenario, you'll also need the electronic mapping application, MARPLOT, as well as the sample map of Prince William County supplied with MARPLOT.

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## Example 1: A Tank Source (Puddle and Pool Fire)

In a small industrial park outside Baton Rouge, Louisiana, a 500-gallon, 4-foot-diameter, vertical tank contains liquid benzene. On August 20, 2006, at 10:30 p.m. local time, a security guard discovers that liquid is leaking out of the tank through a 6-inch circular hole located 10 inches above the bottom of the tank. He also sees that the liquid is flowing onto a paved area in the industrial park. The guard thinks that the tank has just been filled that evening.

The temperature on scene is 80°F, with the wind from the southwest at 7 miles per hour (as measured at a height of 10 meters by a fixed meteorological tower at the site). The sky is more than half covered by clouds and the humidity is about 75 percent. A thunderstorm is approaching from the southwest. There is no low-level inversion. There are very few buildings in the industrial park and a large grassy field is located to the northeast of the industrial park.

The Local Emergency Planning Committee has requested that on-scene responders use ERPG-2 concentrations to define the toxic endpoints in their analysis of benzene hazards.

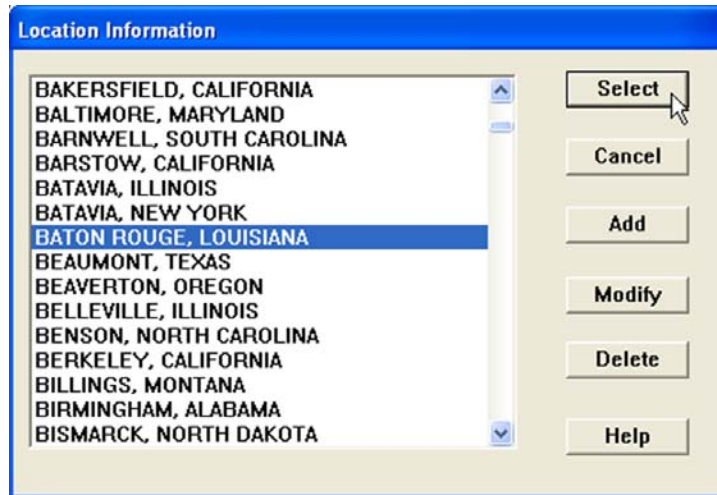
In this example scenario, you'll determine:

1. Distance to the ERPG-2 level if the puddle evaporates and forms a toxic vapor cloud; and
2. Thermal radiation threat if the puddle is ignited by a lightning strike and forms a pool fire.

### Choosing a location and a chemical

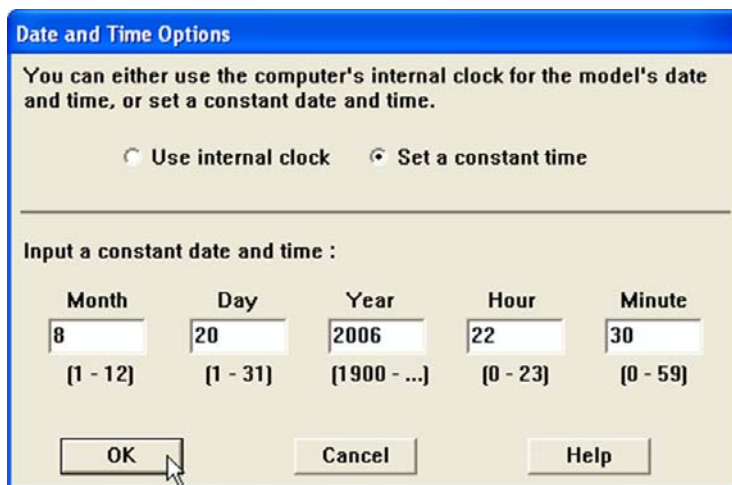
1. Start ALOHA. (In Windows, click the **Start** button, point to **Programs**, then choose the **ALOHA** item. On a Macintosh, double-click the **ALOHA** program icon located in the **ALOHA Folder**.)
2. Read the list of ALOHA's limitations (click **Help** to see more details), then click **OK**.
3. Select **Location** from the **SiteData** menu. A Location Information dialog box appears with a list of the names of cities included in ALOHA's location library.

- The industrial park is located outside Baton Rouge, Louisiana. Type the characters “ba” to quickly move to the section of the list containing names beginning with “ba.” Scroll down a little farther until you see BATON ROUGE, LOUISIANA. Click on this name to highlight it, then click **Select**.

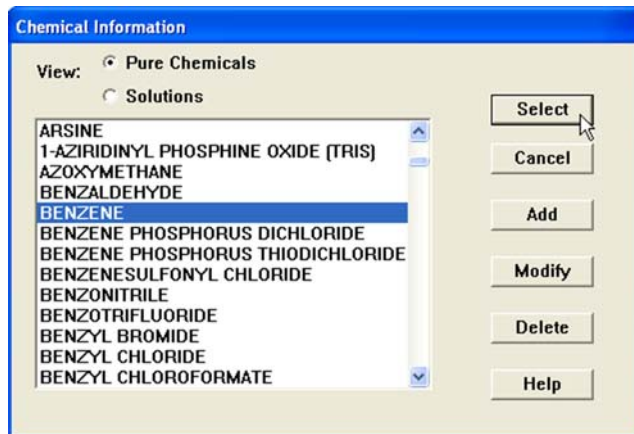


In this example, you will not modify the default building type settings because you will not assess indoor concentration at specific locations.

- Select **Date & Time** from the **SiteData** menu. A Date and Time Options dialog box appears.
- The release occurs on August 20, 2006 at 10:30 p.m. Select the **Set a constant time** option. Enter the month, day, year, hour and minute for this scenario (press Tab to move from one box to the next). ALOHA requires you to convert the time of day into 24-hour time (click Help to learn how to convert time values). Click **OK**.



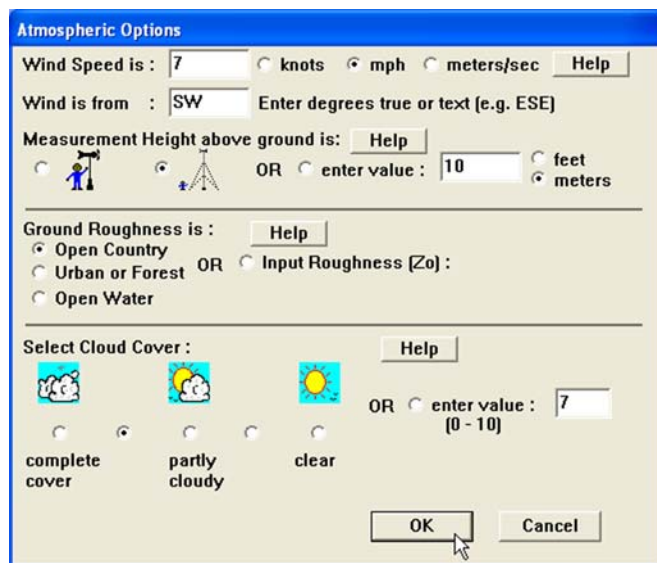
- To choose the chemical that is being released—benzene—select **Chemical** from the **SetUp** menu. A Chemical Information dialog box appears with a list of the chemicals in ALOHA's chemical library.
- Select **Pure Chemicals** at the top of the window (this should be the default). Find **BENZENE** in the list (type the character “b” to locate benzene more rapidly in the list), click on this name, then click **Select**.



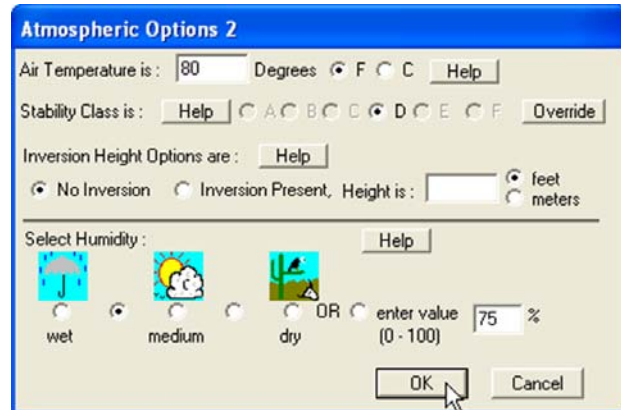
## Entering weather information

Now that you've selected the location, time, and chemical, you must provide information about weather conditions and ground roughness.

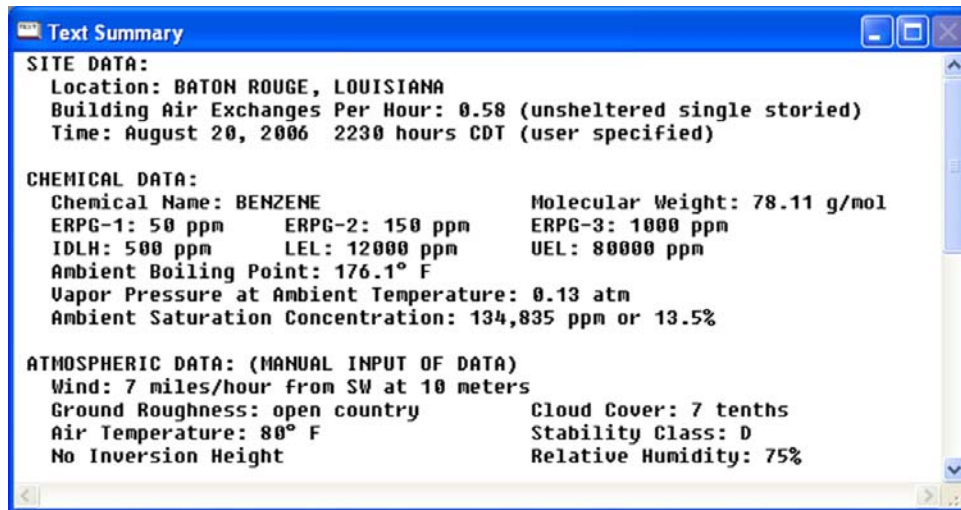
- In the **SetUp** menu, point to **Atmospheric**, then select **User Input**. The first Atmospheric Options dialog box appears.
- The wind is travelling from the southwest at a speed of 7 miles per hour. Type “7” in the wind speed box, then select **mph**. Type “SW” in the wind direction box.
- The wind conditions are measured at a height of 10 meters. Select the **tower icon** in the Measurement Height section. Notice that ALOHA has filled in a value of 10 meters.
- There are very few buildings in the industrial park and a large grassy field is located to the northeast (the area where the wind would blow the toxic vapor cloud). Select the **Open Country** ground roughness option.
- The sky is more than half covered by clouds. Under Select Cloud Cover, choose the second option from the left (the option between the complete cover and partly cloudy options). Notice that ALOHA has filled in a value of 7. Click **OK**. The second Atmospheric Options dialog box appears.



6. The air temperature is 80°F. Type “80” in the air temperature box, then select **F**.
7. ALOHA uses the wind speed, cloud cover, and date and time information that you’ve entered to automatically select atmospheric Stability Class D, representing conditions of neutral atmospheric stability.
8. There is no low-level inversion. Check to be sure that **No inversion** is selected.
9. The relative humidity is about 75 percent. Choose the second option from the left (the option between the wet and medium options). Notice that ALOHA has filled in a value of 75 percent. Click **OK**.



The information that you have entered into ALOHA appears in the Text Summary. Ignore ALOHA’s estimate of building exchange rate, since you are not considering infiltration into buildings.



## Describing the release

Now you're ready to enter information about the release itself—that is, to “set the source”—for this release.

1. The benzene is leaking from a tank. In the **SetUp** menu, point to **Source**, then select **Tank**. A Tank Size and Orientation dialog box appears.
2. The benzene is stored in a 500-gallon, 4-foot-diameter, vertical tank. Select **Vertical cylinder**. Type “500” in the volume box, then select **gallons**. Type “4” in the diameter box, then select **feet**. Notice that ALOHA automatically calculates the tank length. Click **OK**. A Chemical State and Temperature dialog box appears.

3. The benzene is stored in the tank as a liquid (notice in the Text Summary that it has a boiling point of 176°F, well above the ambient temperature). Select the **Tank contains liquid** option. Check to be sure that **Chemical stored at ambient temperature** is selected. Click **OK**. A Liquid Mass or Volume dialog box appears.

4. The security guard thinks the 500-gallon tank was filled that evening, so the most conservative estimate you can make is that the tank is 100 percent full. Either (1) type “100” in the % full by volume box, (2) type “500” in the liquid volume box, then click **gallons**, or (3) scroll the liquid level bar to the top of the tank diagram. Notice that ALOHA fills in the other values. Click **OK**. A Type of Tank Failure dialog box appears.

Liquid Mass or Volume

Enter the mass in the tank OR volume of the liquid

The mass in the tank is: 1.82

pounds

tons(2,000 lbs)

kilograms

OR

Enter liquid level OR volume

The liquid volume is: 500

gallons

cubic feet

liters

cubic meters

100 % full by volume

OK Cancel Help

5. Initially, the benzene is leaking from a hole in the tank, but it is not burning. Choose the **Leaking tank, chemical is not burning and forms an evaporating puddle** option. Click **OK**. An Area and Type of Leak dialog box appears.

Type of Tank Failure

Scenario:  
Tank containing an unpressurized flammable liquid.

Type of Tank Failure:

Leaking tank, chemical is not burning and forms an evaporating puddle

Leaking tank, chemical is burning and forms a pool fire

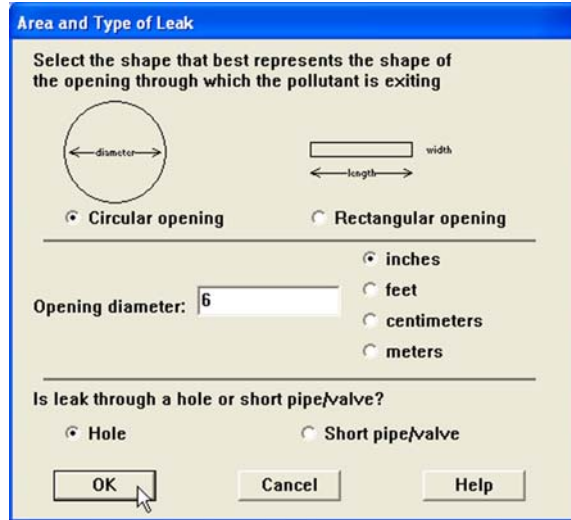
BLEVE, tank explodes and chemical burns in a fireball

Potential hazards from flammable chemical which is not burning as it leaks from tank:

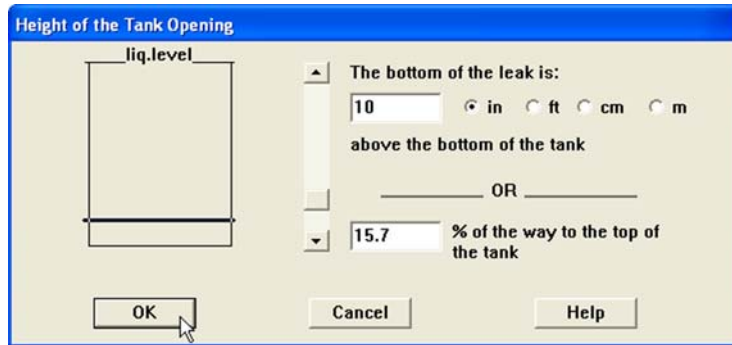
- Downwind toxic effects
- Vapor cloud flash fire
- Overpressure (blast force) from vapor cloud explosion

OK Cancel Help

- The benzene is leaking from a 6-inch circular hole. Check to be sure that **Circular opening** is selected. Type "6" in the opening diameter box and select **inches**. Choose the **Hole** option. Click **OK**. A Height of the Tank Opening dialog box appears.



- The hole is 10 inches above the bottom of the tank. Type "10" in the bottom of the leak box and select **in**. Notice that ALOHA fills in the other values. Click **OK**. A Puddle Parameters dialog box appears.





8. The liquid benzene is flowing onto a paved area in the industrial park. Select the **Concrete** ground type. Since you have no information about the ground temperature, select **Use air temperature (select this if unknown)**. Because the product is flowing onto a paved area, it is probably not contained by a dike so it will continue spreading outward until it reaches a minimum thickness. Under the “Input maximum puddle diameter or area” heading, click **Unknown**. ALOHA will calculate the area for you based on the release information you provided (up to a maximum diameter of 200 meters). Click **OK**.

**Puddle Parameters**

Select ground type Help

- Default soil (select this if unknown)
- Concrete
- Sandy dry soil
- Moist sandy soil
- Water

---

Input ground temperature Help

- Use air temperature (select this if unknown)
- Ground temperature is  deg.  F  C

---

Input maximum puddle diameter or area Help

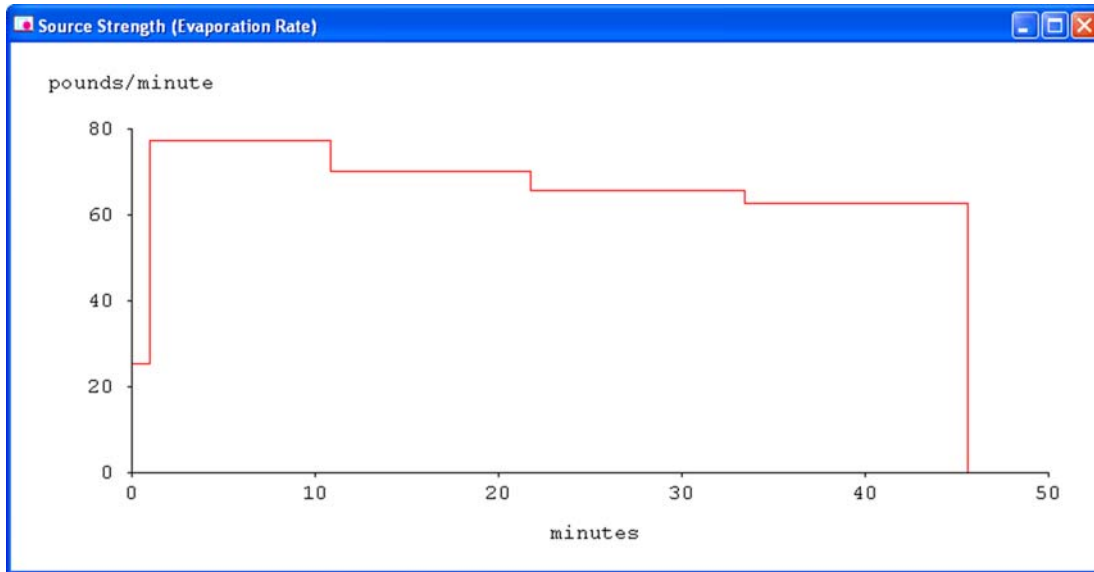
- Unknown
- Maximum diameter  ft
- Maximum area is   yds
- meters

The source strength information that you have entered, and the results of ALOHA’s source strength calculations, appear in the Text Summary. ALOHA estimates that the release of vapor into the atmosphere lasts for about 46 minutes, and that the maximum amount of vapor released at any one time is 77.2 pounds per minute (this is the Maximum Average Sustained Release Rate). ALOHA estimates that the puddle reached a maximum diameter of 21.7 yards.

**Text Summary**

**SOURCE STRENGTH:**  
 Leak from hole in vertical cylindrical tank  
 Flammable chemical escaping from tank (not burning)  
 Tank Diameter: 4 feet      Tank Length: 5.32 feet  
 Tank Volume: 500 gallons  
 Tank contains liquid      Internal Temperature: 80° F  
 Chemical Mass in Tank: 1.82 tons      Tank is 100% full  
 Circular Opening Diameter: 6 inches  
 Opening is 10 inches from tank bottom  
 Ground Type: Concrete  
 Ground Temperature: equal to ambient  
 Max Puddle Diameter: Unknown  
 Release Duration: 46 minutes  
 Max Average Sustained Release Rate: 77.2 pounds/min  
 (averaged over a minute or more)  
 Total Amount Released: 3,082 pounds  
 Note: The chemical escaped as a liquid and formed an evaporating puddle.  
 The puddle spread to a diameter of 21.7 yards.

9. Choose **Source Strength** from the **Display** menu to see the source strength graph for this scenario. The graph shows the predicted averaged release rate during the hour after the release begins.



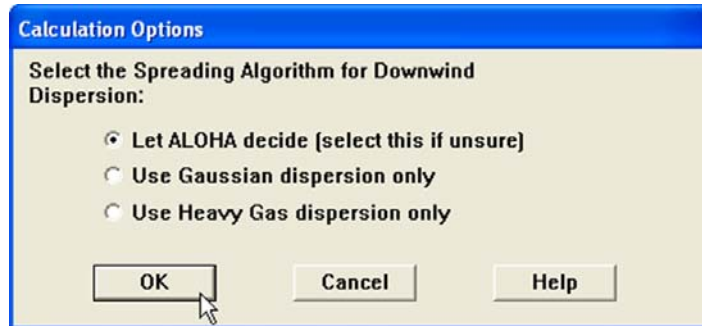
Whenever you run ALOHA, ask yourself: Is ALOHA accurately representing what is actually occurring in this scenario? In this case, liquid benzene leaks from a tank to form a puddle; ALOHA expects that because the puddle is undiked, it spreads out to cover a large area and evaporates at a high rate for a relatively short period of time. What if the puddle were constrained by small depressions in the ground? The puddle would not spread out as far because the liquid flowing away from the tank would fill up the depressions in the ground. The puddle would then be smaller in area and deeper. It would evaporate at a slower rate and it would take longer to completely evaporate.

Because ALOHA assumes that the puddle is on a perfectly flat surface and would spread out until it was very thin, ALOHA may overestimate the real puddle size and evaporation rate. At a real accident scene, check for terrain features that would constrain the puddle from spreading; use this information to estimate the maximum puddle area.

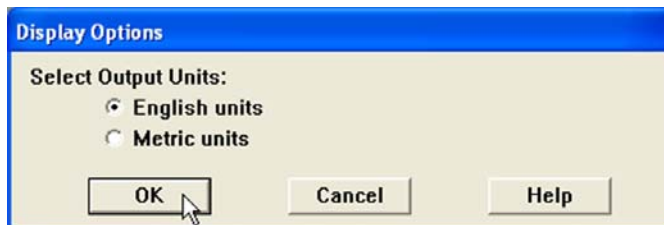
## Checking the Calculation and Display Options Settings

You don't know if the toxic gas is a heavy gas or not, so you'll want ALOHA to use information about the properties of the chemical and the amount of chemical released to choose whether to make Gaussian or heavy gas dispersion computations. Check to be sure that ALOHA is set to this default.

1. Select **Calculation Options** from the **SetUp** menu. A Calculation Options dialog box appears.
2. Check to be sure that **Let ALOHA decide (select this if unsure)** is selected. Click **OK**.



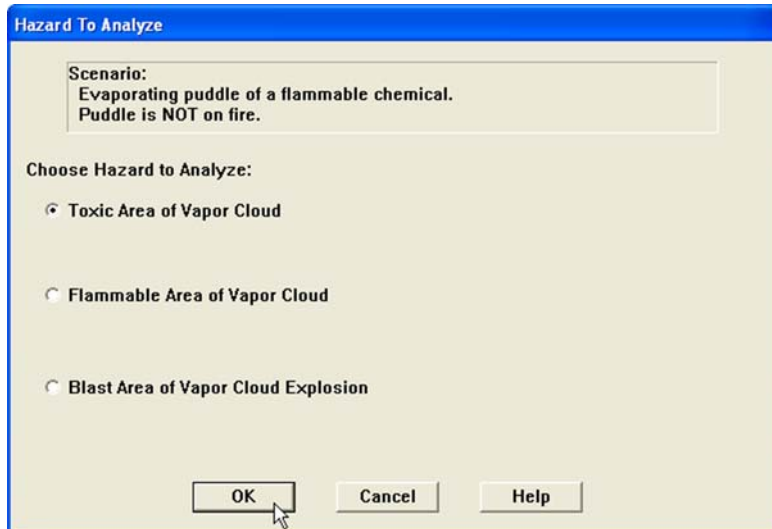
3. Select **Display Options** from the **Display** menu. A Display Options dialog box appears. Select **English units** and ALOHA's computation results will be displayed in those units. (When running ALOHA, you can choose either type of units, but for this example English units have been selected.) Click **OK**.



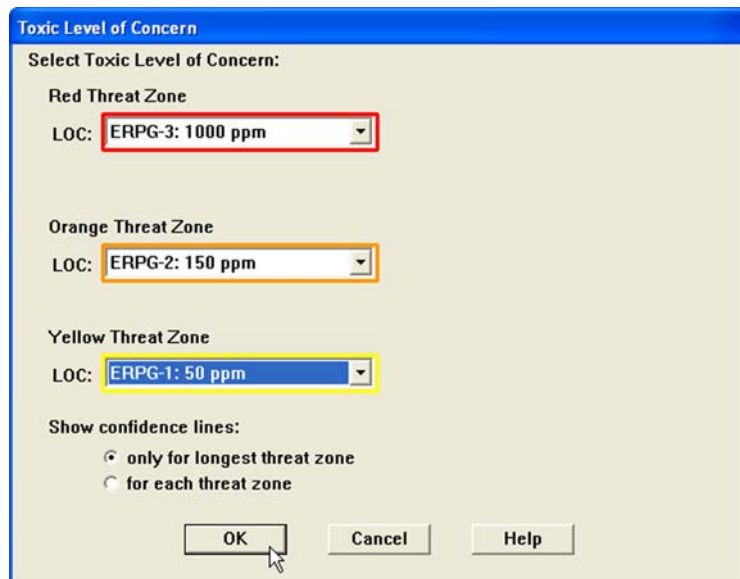
## Choosing LOCs and creating a threat zone plot

1. Choose **Threat Zone** from the **Display** menu. A Hazard To Analyze dialog box appears.

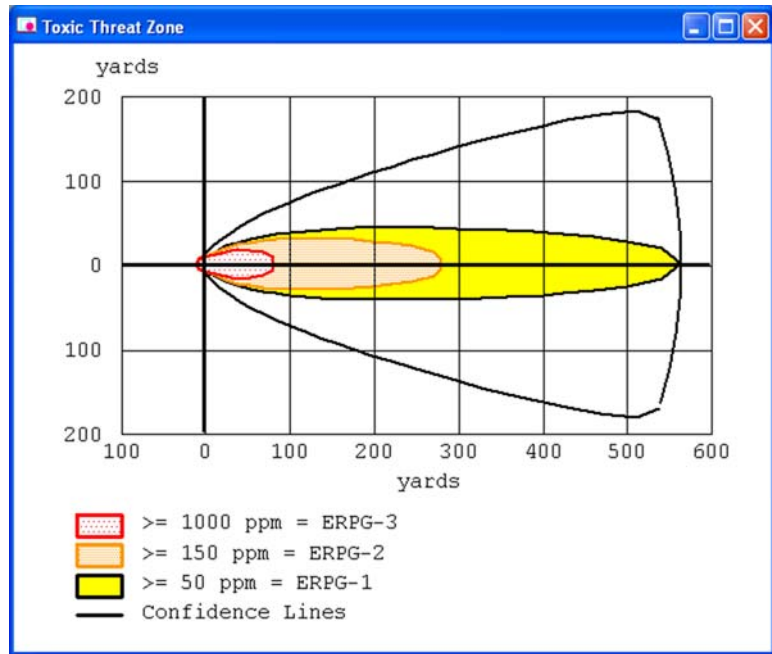
- As the puddle evaporates, a vapor cloud forms. ALOHA can help you model three possible hazardous scenarios for the flammable vapor cloud: toxic area, flammable area, or blast area. For this example, you want to display the toxic area on a threat zone plot. Select the **Toxic Area of Vapor Cloud** option. Click **OK**. A Toxic Level of Concern dialog box appears.



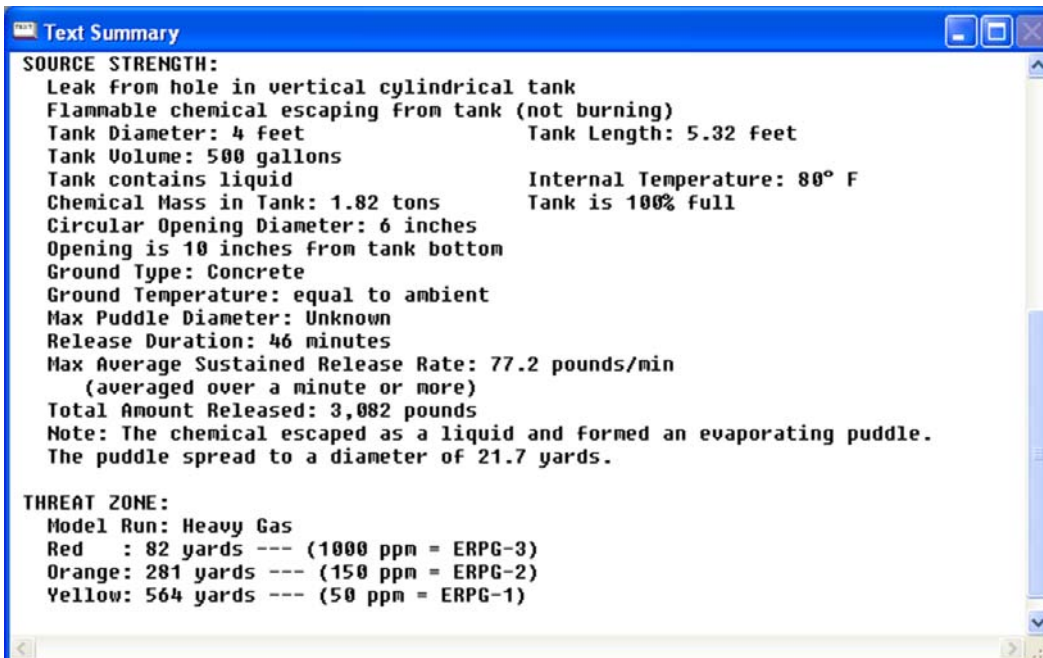
- ALOHA uses ERPGs (Emergency Response Planning Guidelines) as the default LOCs for benzene, so you'll keep the default LOCs and check that **Show confidence lines only for the longest threat zone** has been selected. Click **OK**. ALOHA will display a threat zone plot for this release.



You'll see ALOHA's threat zone plot for this scenario, showing three toxic threat zones. You want to know the downwind distance to the ERPG-2 level specified by the Local Emergency Planning Committee. ALOHA estimates that the orange threat zone—the ERPG-2 level—will extend 281 yards downwind (the exact value for this *threat distance* is displayed in the Text Summary). Within this zone, ground-level benzene concentrations might exceed the ERPG-2 level. At concentrations above the ERPG-2 level, people could experience serious health effects or find their ability to escape to be impaired (if they are exposed for about an hour).



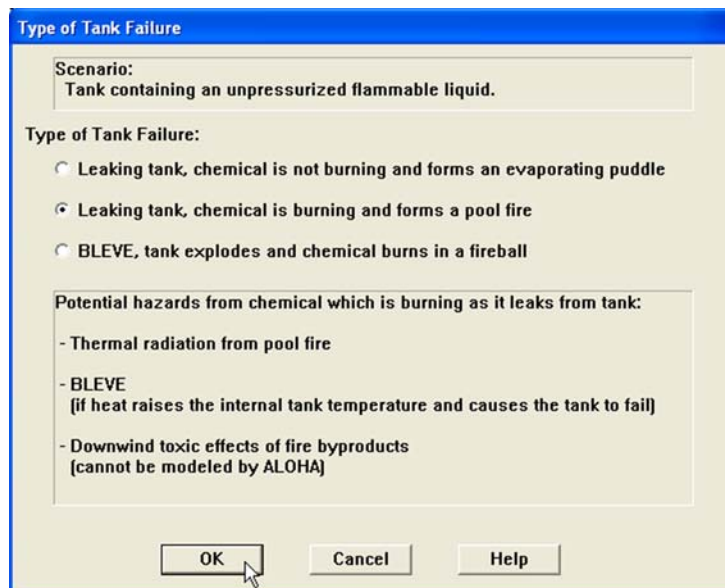
Check the Text Summary for this release.



## Modeling a second scenario: pool fire

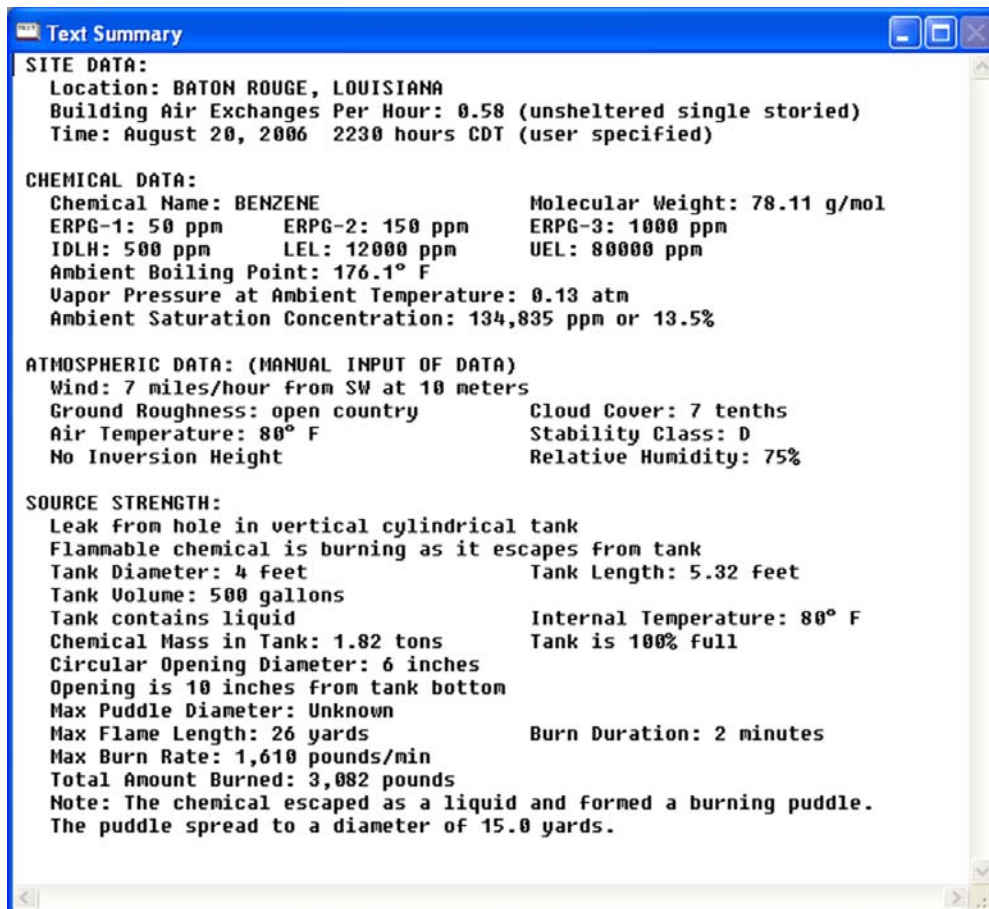
Now that ALOHA has displayed the downwind distance to the ERPG-2 level, you want to assess the thermal radiation threat if the puddle is ignited by a lightning strike (or other ignition source) and forms a pool fire. For this example, you want to assess the threat assuming that the pool fire occurs soon after the puddle forms. Therefore, you do not need to enter new information for time, atmospheric conditions, or puddle size.

1. When you run multiple scenarios for the same incident, the plots and Text Summary screen from the first scenario will change when you enter new information. Before you start running an additional scenario, either **print** out the threat zone plot and the Text Summary screen or paste them into a word processing document. You'll need the original information to compare the scenarios later.
2. **Close** the threat zone plot window.
3. When you set the source for the first scenario, you told ALOHA that the benzene was leaking from a tank, but it was not burning. You need to return to the Type of Tank Failure screen and tell ALOHA that now the chemical is burning and it has formed a pool fire. Begin by selecting the Tank source again. In the **SetUp** menu, point to **Source**, then select **Tank**. A Tank Size and Orientation dialog box appears.
4. Notice that all of your original information is already entered into the dialog box. The dimensions of the tank have not changed, so you can just click **OK** to move to the next screen.
5. Your original information is still correct on the Chemical State and Temperature and the Liquid Mass or Volume dialog boxes. Click **OK** on each screen until the Type of Tank Failure dialog box appears.
6. Choose the **Leaking tank, chemical is burning and forms a pool fire** option. Click **OK**. An Area and Type of Leak dialog box appears.

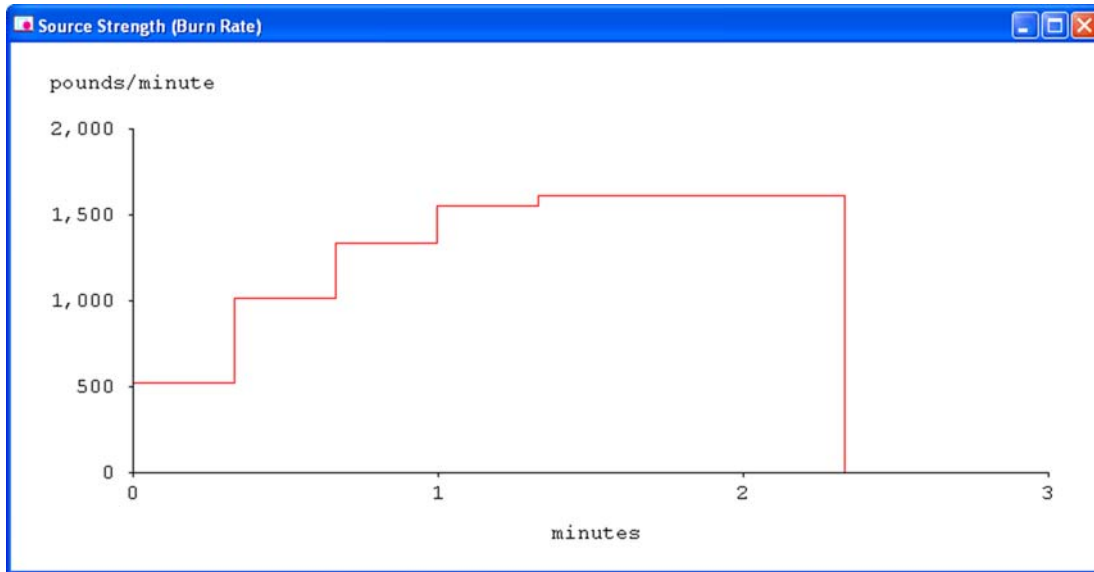


7. Your original information is still correct on the Area and Type of Leak, Height of the Tank Opening, and Maximum Puddle Size dialog boxes. Click **OK** on each screen.

The source strength information that you have entered, and the results of ALOHA's source strength calculations, appear in the Text Summary. ALOHA estimates that the puddle burns for about two minutes, and that the Maximum Burn Rate is 1,610 pounds per minute. Notice that ALOHA estimates that the puddle reached a maximum diameter of 15.0 yards, which is smaller than the 21.7 yards estimated for the evaporating puddle because the chemical is being consumed in the fire before the puddle can spread to the larger diameter.



- Choose **Source Strength** from the **Display** menu to see the source strength graph for this scenario. The graph shows the predicted averaged burn rate.



ALOHA estimates that the pool fire would last just under 2 and a half minutes. (In the Text Summary, ALOHA listed the burn duration as 2 minutes. ALOHA rounds duration estimates to the nearest whole minute on the Text Summary screen, but uses the more precise source strength value in its threat calculations.) The increase in burn rate for the first minute and a half is due to the growing puddle size as the chemical continues to leak from the tank.

### Choosing LOCs and creating a threat zone plot for the pool fire

- Choose **Threat Zone** from the **Display** menu. A Thermal Radiation Level of Concern dialog box appears.
- You want to know the thermal radiation threat for the pool fire. Keep ALOHA's default LOCs and click **OK**. ALOHA will display a threat zone plot for this release.

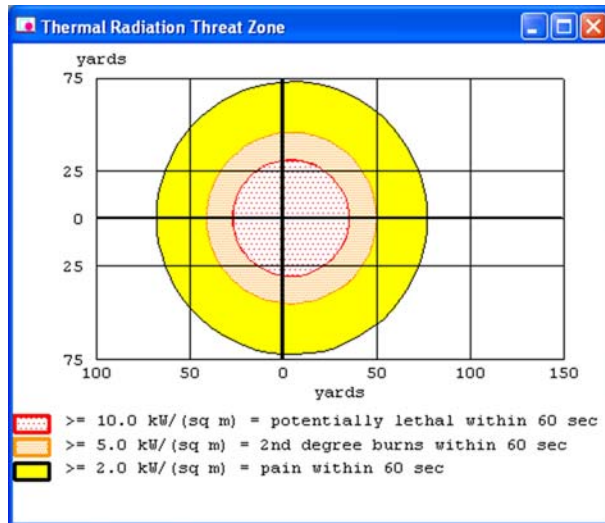
The dialog box, titled "Thermal Radiation Level of Concern", allows the user to select the Thermal Radiation Level of Concern (LOC) for different threat zones. The dialog box contains three sections, each with a dropdown menu for the LOC:

- Red Threat Zone:** LOC: 10.0 kW/[sq m] = potentially lethal within 60 sec
- Orange Threat Zone:** LOC: 5.0 kW/[sq m] = 2nd degree burns within 60 sec
- Yellow Threat Zone:** LOC: 2.0 kW/[sq m] = pain within 60 sec

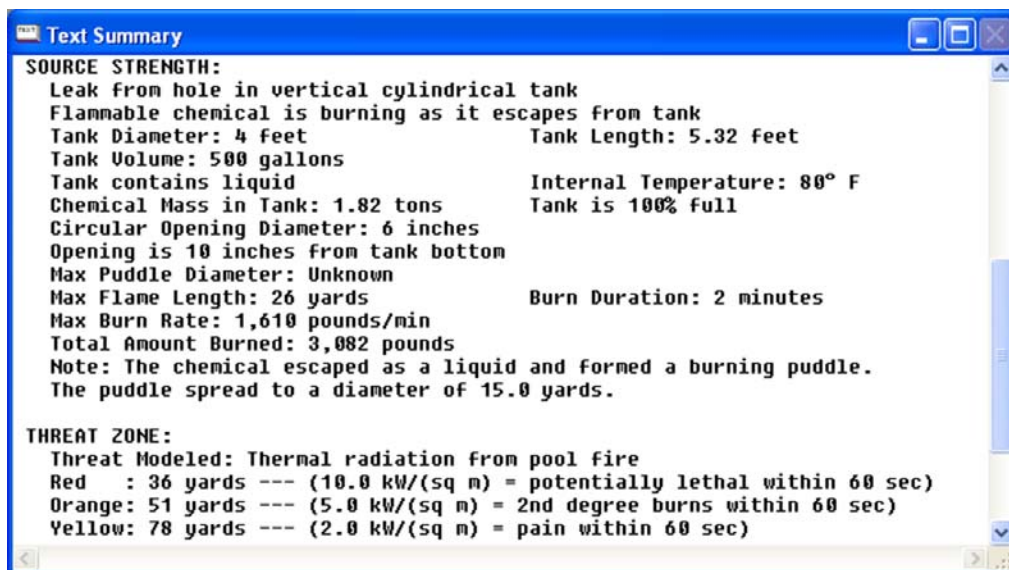
At the bottom of the dialog box, there are three buttons: **OK**, **Cancel**, and **Help**.



You'll see ALOHA's threat zone plot for this scenario, showing three nearly circular thermal radiation threat zones. The red threat zone represents the worst hazard level, and the orange and yellow threat zones represent areas of decreasing hazard. Unlike the toxic threat, the thermal radiation threat extends in all directions simultaneously. But it extends a little farther in the downwind direction. For example, ALOHA estimates that the orange threat zone will extend 51 yards in the downwind direction. This threat distance is shown in the Text Summary. The orange threat zone extends only about 40 yards in the upwind direction. This difference exists because the wind tilts the flames in the downwind direction—leading to a greater thermal radiation threat in that direction. It is important to realize that there may be additional hazards that are not modeled by ALOHA, including secondary fires and explosions.

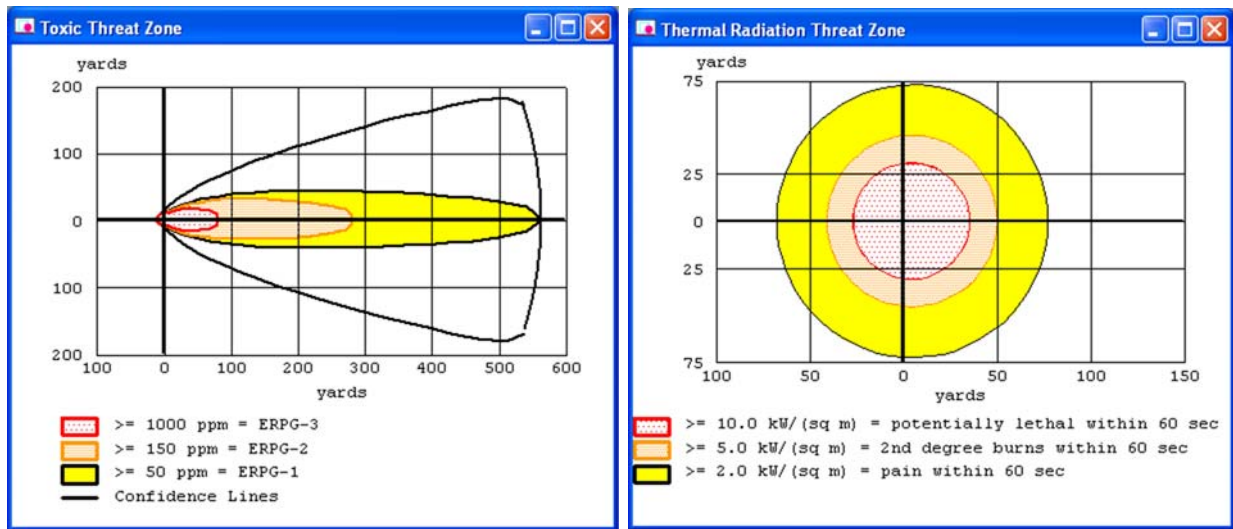


Check the Text Summary for this release.



Compare the threat zone plots and the Text Summary screens from both of the scenarios. (Below, the toxic threat zone plot is shown on the left and the threat distances from the Text Summary screens are summarized in a table.) The origin (0,0) on both plots represents the center of the puddle. ALOHA estimates that the red toxic threat zone—the worst hazard level—extends primarily in the downwind direction for about 82 yards. The worst of the thermal radiation threat (the red zone) is predicted to extend roughly 30 yards in all directions—and a little farther in the downwind direction.

Notice the role that the direction of the wind plays in both scenarios. The toxic threat is confined primarily to the area downwind of the release, and even though the thermal radiation threat occurs in all directions it too is shifted downwind from the origin.



Scenario	Threat Modeled	Red Threat Zone	Orange Threat Zone	Yellow Threat Zone
Toxic dispersion	Toxicity	82 yards	281 yards	564 yards
Pool fire	Thermal radiation	36 yards	51 yards	78 yards

## Example 2: A Tank Source (Multiple Scenarios)

On June 25, 2006, at 12:30 p.m., a train derails in a highly industrialized section of Columbia, South Carolina. Among the derailed cars is a tank car of propane in a U.S. Department of Transportation (DOT) class 112J400W car with a listed capacity of 33,800 gallons. The tank is approximately 70 feet long and the tank appears to be intact. The propane has been liquefied under pressure.

At the time of the accident, the air temperature is 70°F, with the wind from 360° at 10 miles per hour (measured at a height of 10 meters by the National Weather Service). The sky is completely overcast and the relative humidity is 67 percent. There is no low-level inversion.

The tank needs to be removed from the tracks and the cargo off-loaded. The tank has already been subjected to significant stress during the wreck and it is conceivable that it could fail during this effort. Possible failure scenarios include:

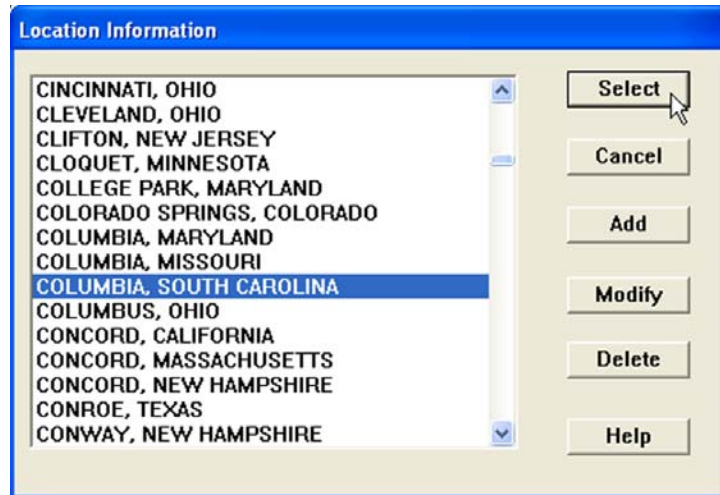
- A sudden catastrophic failure leading to a Boiling Liquid Expanding Vapor Explosion (BLEVE);
- A leak leading to a flash fire or a vapor cloud explosion; or
- A breach leading to a jet of flame from the tank.

In order to plan a safe response and ensure public safety, the potential severity of these threats must be evaluated. You will use ALOHA to predict the threat zones for each of these potential scenarios. For the last two scenarios, you will model the release assuming a seam fails on the tank, creating a rectangular hole 40 inches long and 0.1 inch wide.

### Choosing a location and a chemical

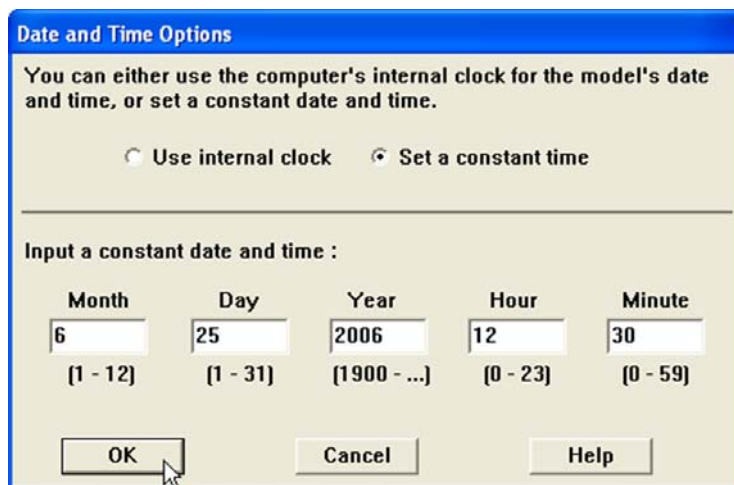
1. Start ALOHA. (In Windows, click the **Start** button, point to **Programs**, then choose the **ALOHA** item. On a Macintosh, double-click the **ALOHA** program icon located in the **ALOHA Folder**.)
2. Read the list of ALOHA's limitations (click **Help** to see more details), then click **OK**.
3. Select **Location** from the **SiteData** menu. A Location Information dialog box appears with a list of the names of cities included in ALOHA's location library.

- The train derailed in Columbia, South Carolina. Type the characters “co” to quickly move to the section of the list containing names beginning with “co.” Scroll down a little farther until you see COLUMBIA, SOUTH CAROLINA. Click on this name to highlight it, then click **Select**.

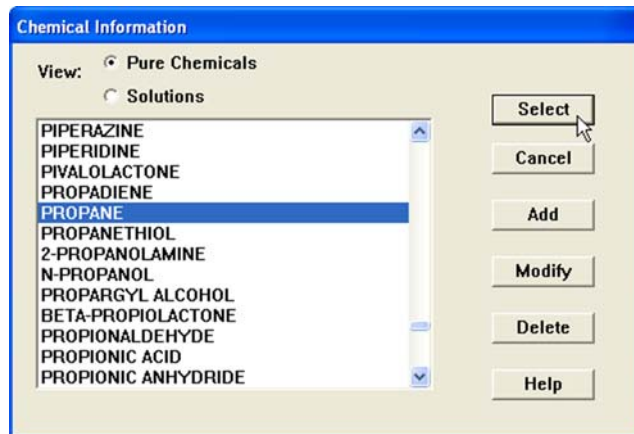


In this example, you will not modify the default building type settings because you will not assess indoor concentration at specific locations.

- Select **Date & Time** from the **SiteData** menu. A Date and Time Options dialog box appears.
- The release occurs on June 25, 2006 at 12:30 p.m. Select the **Set a constant time** option. Enter the month, day, year, hour and minute for this scenario (press Tab to move from one box to the next). ALOHA requires you to convert the time of day into 24-hour time (click Help to learn how to convert time values). Click **OK**.



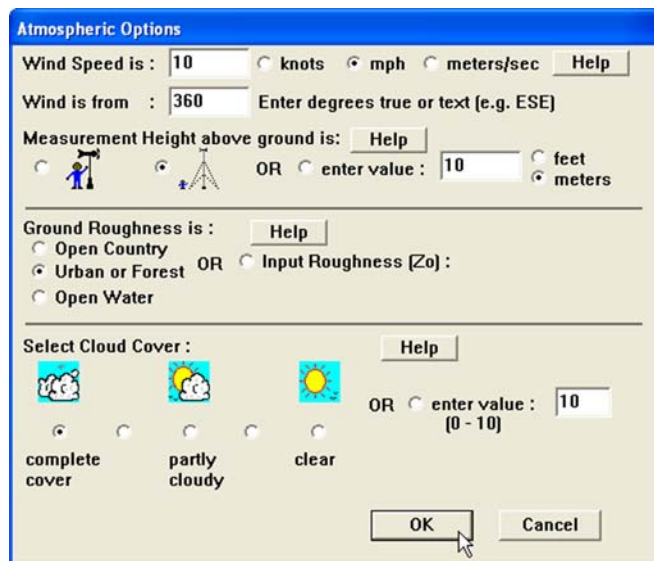
- To choose the chemical that is in the tank—propane—select **Chemical** from the **SetUp** menu. A Chemical Information dialog box appears with a list of the chemicals in ALOHA's chemical library.
- Select **Pure Chemicals** at the top of the window (this should be the default). Find PROPANE in the list (quickly type the characters “pr” to locate propane more rapidly in the list), click on this name, then click **Select**.



## Entering weather information

Now that you've selected the location, time, and chemical, you must provide information about weather conditions and ground roughness.

- In the **SetUp** menu, point to **Atmospheric**, then select **User Input**. The first Atmospheric Options dialog box appears.
- The wind is travelling from 360° at a speed of 10 miles per hour. Type “10” in the wind speed box, then select **mph**. Type “360” in the wind direction box.
- The wind conditions are measured at a height of 10 meters. Select the **tower icon** in the Measurement Height section. Notice that ALOHA has filled in a value of 10 meters.
- The area surrounding the derailed cars is highly industrialized. Select the **Urban or Forest** ground roughness option. Notice that ALOHA has filled in a value of 10. Click **OK**. The second Atmospheric Options dialog box appears.



6. The air temperature is 70°F. Type “70” in the air temperature box, then select **F**.
7. ALOHA uses the wind speed, cloud cover, and date and time information that you’ve entered to automatically select atmospheric Stability Class D, representing conditions of neutral atmospheric stability.
8. There is no low-level inversion. Check to be sure that **No inversion** is selected.
9. The relative humidity is 67 percent. Type “67” in the humidity value box. Click **OK**.

Atmospheric Options 2

Air Temperature is : 70 Degrees  F  C Help

Stability Class is : Help  A  B  C  D  E  F Override

Inversion Height Options are : Help

No Inversion  Inversion Present. Height is : feet meters

Select Humidity : Help

wet  medium  dry OR  enter value : 67 % (0 - 100)

OK Cancel

The information that you have entered into ALOHA appears in the Text Summary. Ignore ALOHA’s estimate of building exchange rate, since you are not considering infiltration into buildings.

Text Summary

**SITE DATA:**  
 Location: COLUMBIA, SOUTH CAROLINA  
 Building Air Exchanges Per Hour: 0.52 (unsheltered single storied)  
 Time: June 25, 2006 1230 hours EDT (user specified)

**CHEMICAL DATA:**  
 Chemical Name: PROPANE Molecular Weight: 44.10 g/mol  
 TEEL-1: 2100 ppm TEEL-2: 2100 ppm TEEL-3: 2100 ppm  
 IDLH: 2100 ppm LEL: 20000 ppm UEL: 95000 ppm  
 Ambient Boiling Point: -42.2° C  
 Vapor Pressure at Ambient Temperature: greater than 1 atm  
 Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

**ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)**  
 Wind: 10 miles/hour from 360° true at 10 meters  
 Ground Roughness: urban or forest Cloud Cover: 10 tenths  
 Air Temperature: 70° F Stability Class: D  
 No Inversion Height Relative Humidity: 67%

## Describing the release

Now you're ready to enter information about the release itself—that is, to “set the source”—for this release. You'll begin by modeling the BLEVE scenario.

1. The propane might leak from a tank car. In the **SetUp** menu, point to **Source**, then select **Tank**. A Tank Size and Orientation dialog box appears.
2. The propane is stored in a 33,800-gallon, 70-foot long, horizontal tank car. Select **horizontal cylinder**. Type “33800” in the volume box, then select **gallons**. Type “70” in the length box, then select **feet**. Notice that ALOHA automatically calculates the tank diameter. Click **OK**. A Chemical State and Temperature dialog box appears.

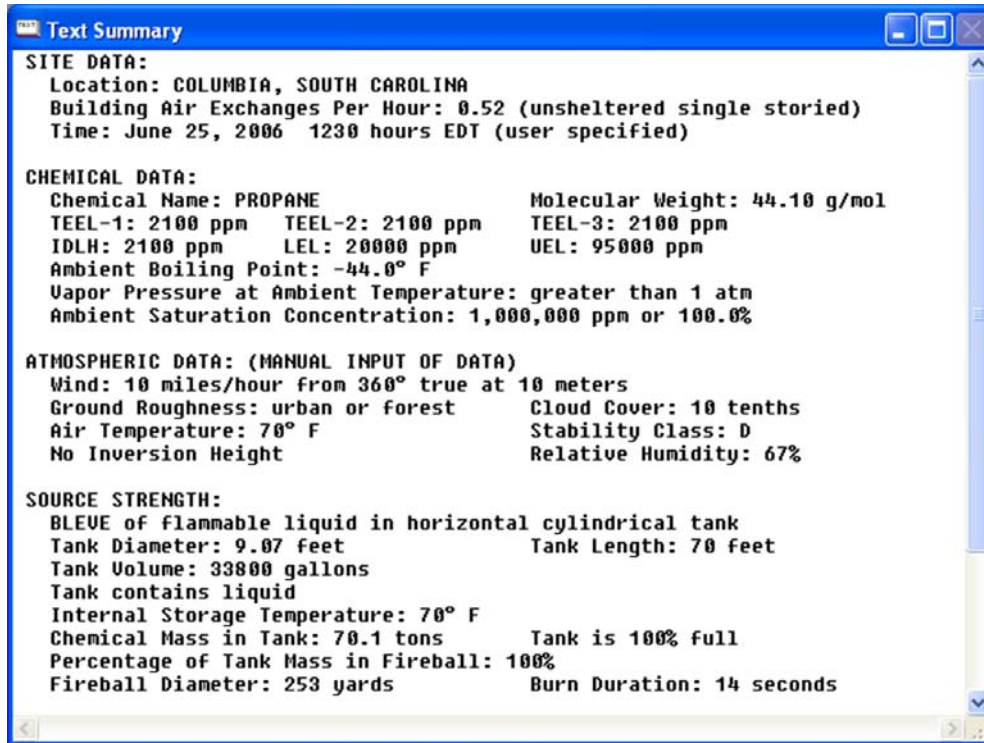
3. The propane is stored in the tank as a liquid; the propane was liquefied by pressure, not by refrigeration. Select the **Tank contains liquid** option. Check to be sure that **Chemical stored at ambient temperature** is selected. Click **OK**. A Liquid Mass or Volume dialog box appears.

- You are not sure how full the tank is, but you want to make a worst-case estimate, so you will assume the tank is filled to capacity (33,800 gallons). Either (1) type “100” in the % full by volume box, (2) type “33800” in the liquid volume box, then click **gallons**, or (3) scroll the liquid level bar to the top of the tank diagram. Notice that ALOHA fills in the other values. Click **OK**. A Type of Tank Failure dialog box appears.

- You want to begin by modeling the potential BLEVE scenario. Choose the **BLEVE, tank explodes and chemical burns in a fireball** option. Click **OK**.

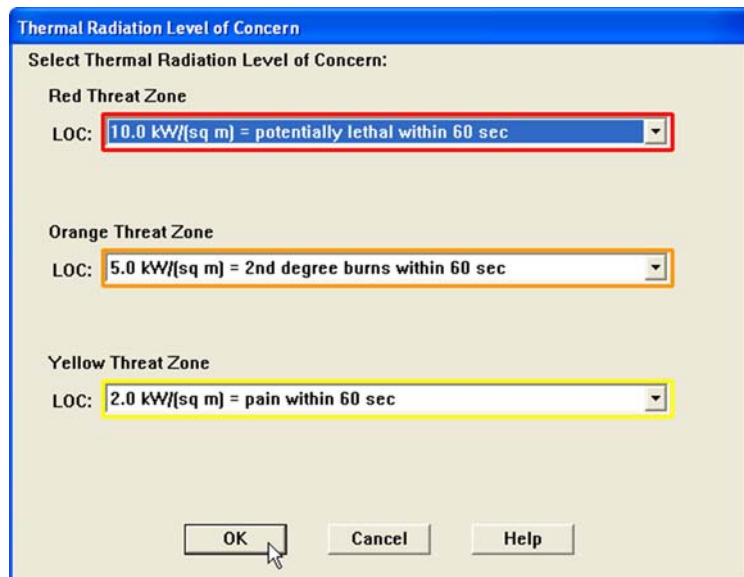


The source strength information that you have entered, and the results of ALOHA's source strength calculations, appear in the Text Summary. ALOHA estimates that the BLEVE fireball has a diameter of about 253 yards and burns for about 14 seconds.

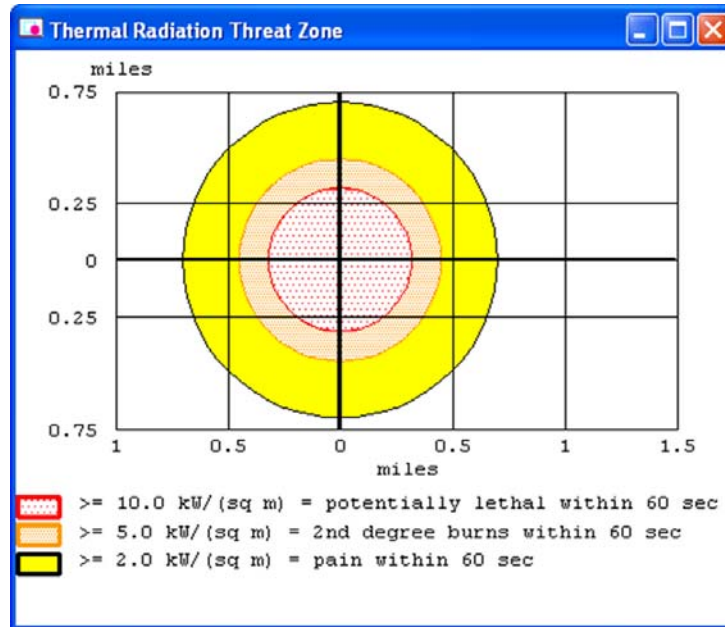


## Choosing LOCs and creating a threat zone plot for a BLEVE

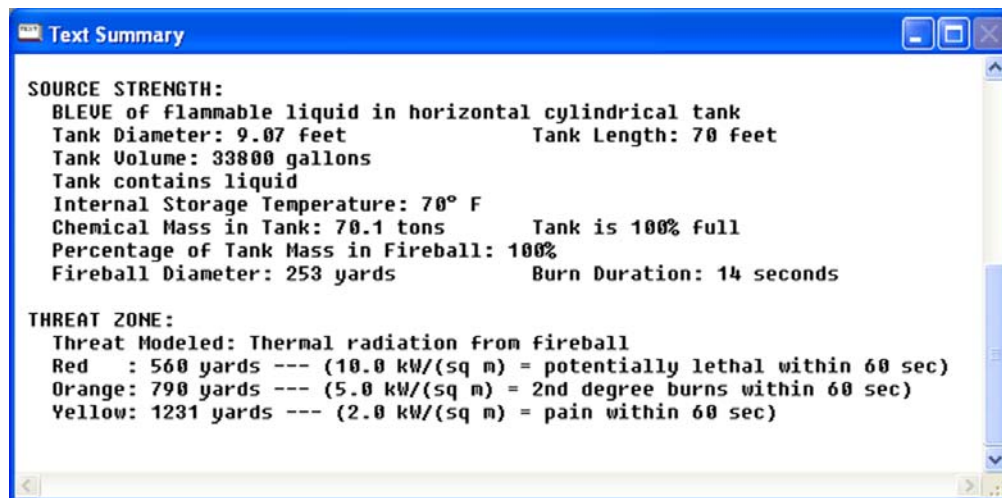
1. Choose **Threat Zone** from the **Display** menu. A Thermal Radiation Level of Concern dialog box appears.
2. You want to know the thermal radiation threat for a BLEVE. Keep ALOHA's default LOCs and click **OK**. ALOHA will display a threat zone plot for this release.



You'll see ALOHA's threat zone plot for this scenario, showing three thermal radiation threat zones. ALOHA estimates that the red threat zone—the worst hazard level—will extend 560 yards in all directions (the threat distance values are displayed in the Text Summary). The orange and yellow threat zones represent areas of decreasing hazard. Check the plot legend to see the hazard that each zone represents. It is important to realize that there may be additional hazards that are not modeled by ALOHA, including hazardous fragments, overpressure, and secondary fires and explosions.



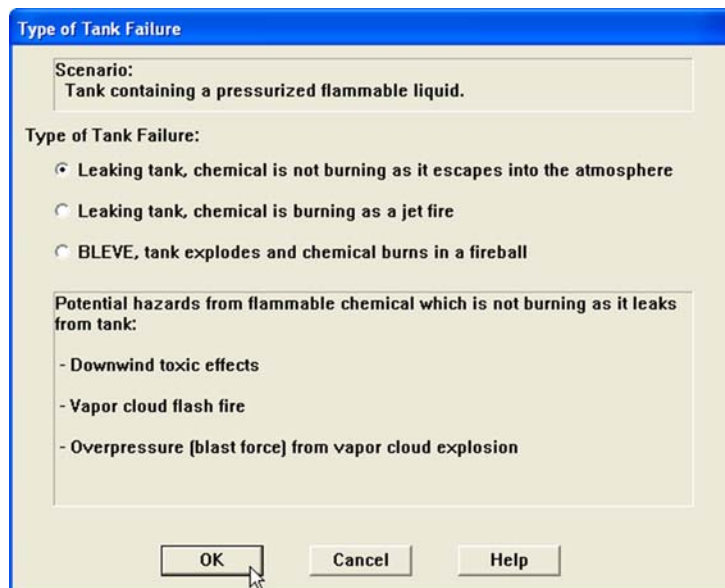
Check the Text Summary for this release to see a summary of the scenario and the threat zones.



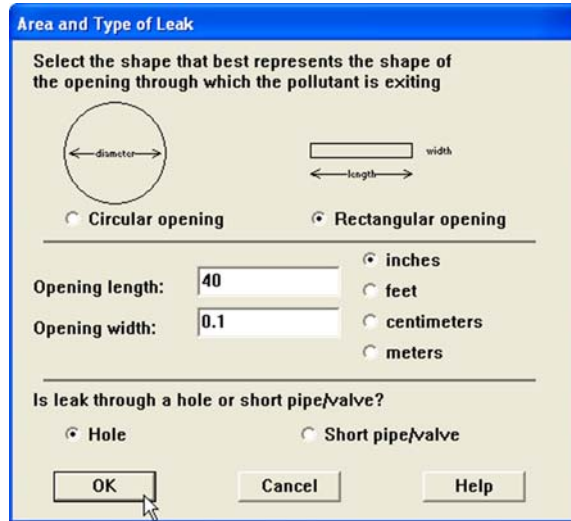
## Modeling a second scenario: flash fire or vapor cloud explosion

Now that ALOHA has displayed the thermal radiation hazard from a BLEVE, you want to assess the threat if the tank leaks and a flammable vapor cloud forms instead. If this situation occurs, either a flash fire or a vapor cloud explosion could occur, depending on the scenario specifics. For both of these scenarios, you will need to begin by estimating the flammable area of the vapor cloud. You do not need to enter new information for time, atmospheric conditions, or tank size.

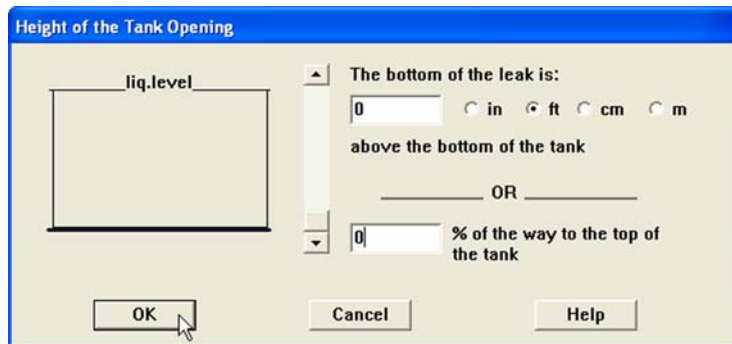
1. When you run multiple scenarios for the same incident, the plots and Text Summary screen from the first scenario will change when you enter new information. Before you start running an additional scenario, either **print** out the threat zone plot and the Text Summary screen or paste them into a word processing document. You'll need the original information to compare the scenarios later.
2. **Close** the threat zone plot window.
3. When you set the source for the first scenario, you told ALOHA that a BLEVE occurred. You need to return to the Type of Tank Failure screen and tell ALOHA that now you want to model a scenario where the chemical is not burning as it escapes into the atmosphere. Begin by selecting the Tank source again. In the **SetUp** menu, point to **Source**, then select **Tank**. A Tank Size and Orientation dialog box appears.
4. Notice that all of your original information is already entered into the dialog box. The dimensions of the tank have not changed, so you can just click **OK** to move to the next screen.
5. Your original information is still correct on the Chemical State and Temperature and the Liquid Mass or Volume dialog boxes. Click **OK** on each screen until the Type of Tank Failure dialog box appears.
6. Choose the **Leaking tank, chemical is not burning as it escapes into the atmosphere** option. Click **OK**. An Area and Type of Leak dialog box appears.



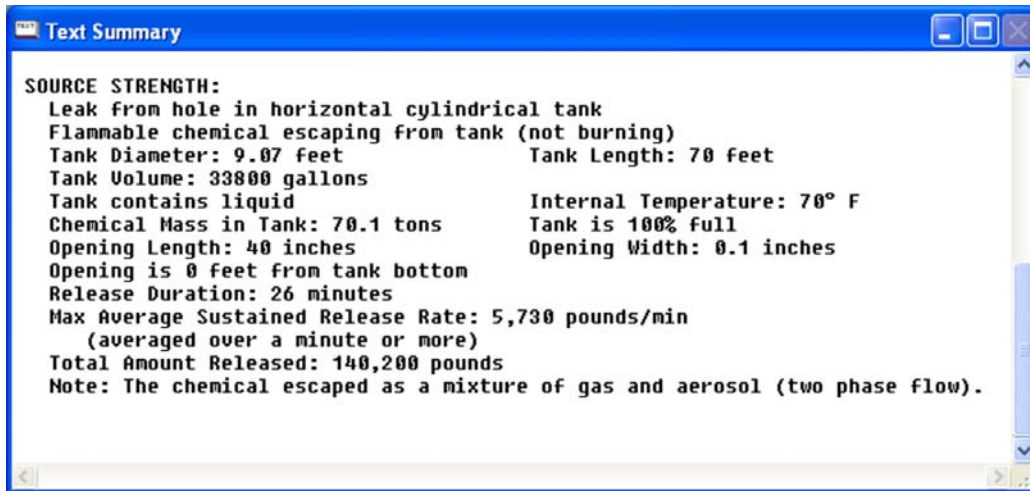
- The tank appears to be intact. However, you want to model a release assuming a seam fails on the tank, creating a rectangular hole 40 inches long and 0.1 inch wide. Select **Rectangular opening**. Type “40” in the opening length box and select **inches**. Type “0.1” in the opening width box. Choose the **Hole** option. Click **OK**. A Height of the Tank Opening dialog box appears.



- Since you are modeling this scenario in order to plan for a potential release, you don't know where the hole might occur. However, a hole that occurs at the bottom of the tank will give the worst-case estimate for this type of scenario because the weight of the remaining propane in the tank will push the propane through the hole faster. Type “0” in the % of the way to the top of the leak box. Click **OK**.

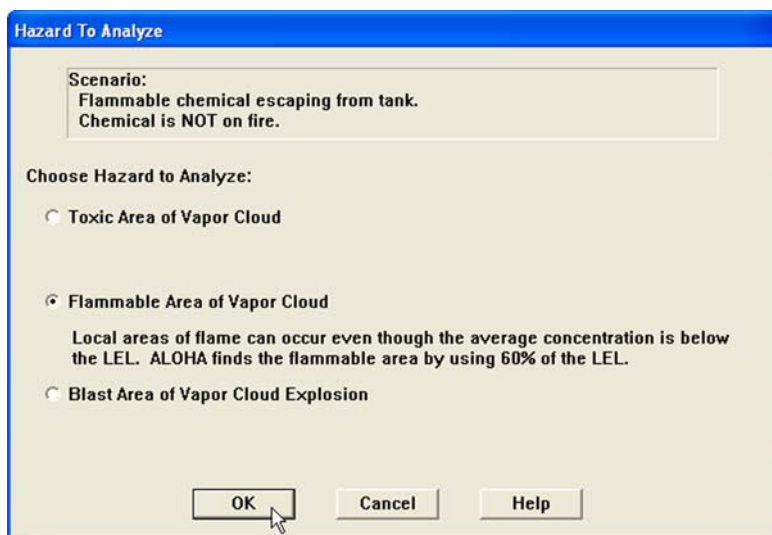


The source strength information that you have entered, and the results of ALOHA's source strength calculations, appear in the Text Summary. ALOHA estimates that the release lasts for about 26 minutes, and that the Maximum Average Sustained Release Rate is 5,730 pounds per minute.



### Choosing LOCs and creating threat zone plots for a flammable vapor cloud

1. Choose **Threat Zone** from the **Display** menu. A Hazard To Analyze dialog box appears.
2. ALOHA can help you model three possible hazardous scenarios for the flammable vapor cloud: toxic area, flammable area, or blast area. For this example, first you want to display the flammable area of the vapor cloud on a threat zone plot. The flammable area is the predicted area where the ground-level vapor (fuel) concentration in air is within the flammable range and can be ignited. Then, you will use the threat zone plot to determine possible ignition sources and the level of congestion within the vapor cloud, both of which affect whether a vapor cloud explosion is possible. Select the **Flammable Area of Vapor Cloud** option. A Flammable Level of Concern dialog box appears.



3. Keep ALOHA's default LOCs and check that **Show confidence lines only for the longest threat zone** has been selected. Click **OK**. ALOHA will display a threat zone plot for this release.

**Flammable Level of Concern**

Select Flammable Level of Concern:

Red Threat Zone  
LOC: 12,000 ppm = 60% LEL = Flame Pockets

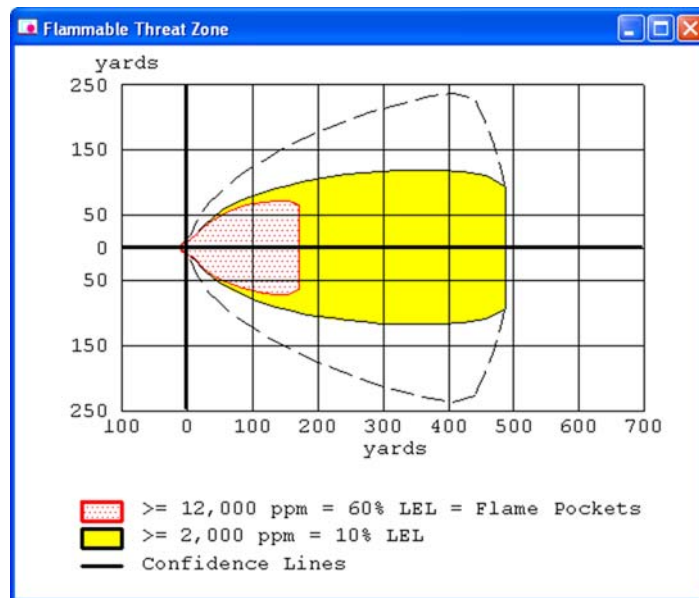
Orange Threat Zone  
LOC: [none]

Yellow Threat Zone  
LOC: 2,000 ppm = 10% LEL

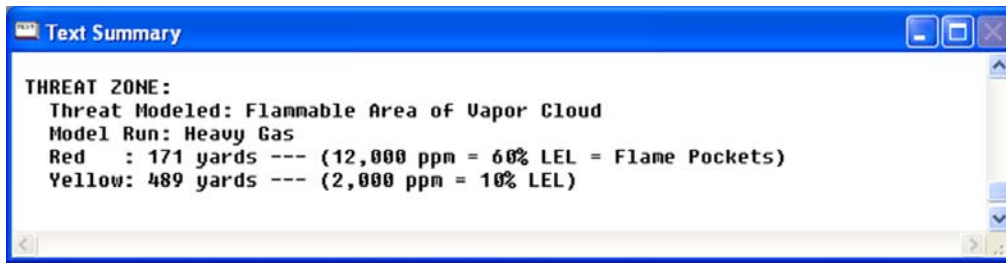
Show confidence lines:  
 only for longest threat zone  
 for each threat zone

OK Cancel Help

You'll see ALOHA's threat zone plot for this scenario, showing two flammable threat zones. The red threat zone represents the estimated flammable area where a flash fire or a vapor cloud explosion could occur at some time after the release begins. ALOHA estimates that the red threat zone will extend 171 yards in the downwind direction. The yellow threat zone represents the estimated area where propane concentrations could exceed 10% LEL, a level often used by responders.



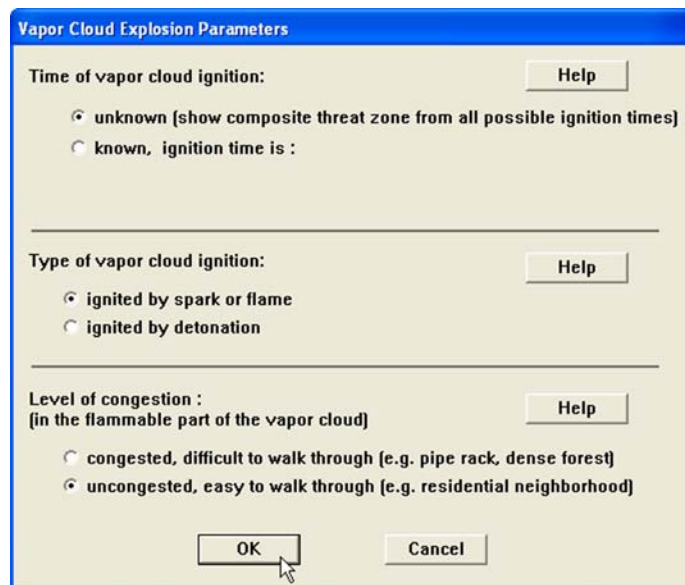
Check the Text Summary for this release.



4. Either **print** out the threat zone plot and the Text Summary screen or paste them into a word processing document. You'll need the information to compare the scenarios later.

Now that you know where the estimated flammable portion of the cloud is, you can identify possible ignition sources and the level of congestion within that area to model a vapor cloud explosion. The portion of the cloud that might participate in a vapor cloud explosion—the red zone on the threat zone plot—is expected to travel through a slightly congested area where there are many likely ignition sources (e.g., mechanical sparks).

5. Choose **Threat Zone** from the **Display** menu. The Hazard To Analyze dialog box appears again. This time, choose **Blast Area of Vapor Cloud Explosion**. Click **OK**. A Vapor Cloud Explosion Parameters dialog box appears.
6. You do not know the ignition time, so select **unknown (show composite threat zone from all possible ignition times)**. Because the flammable area of the vapor cloud is in an industrial area, you determine that the vapor cloud could be ignited—if it ignites—by a mechanical spark. Select **ignited by spark or flame**.



7. The flammable area is slightly congested. However, slightly congested doesn't seem to fit into either of ALOHA's congestion categories. After reading the on-screen help, you are fairly sure that you should choose the uncongested option because it describes the majority of the cloud. However, you also realize that congestion level can affect the severity of a vapor cloud explosion, so you decide to model the explosion twice—once with each congestion option—so that you can compare the potential explosions. Begin by selecting the **uncongested** option, because you feel it is the most accurate guess. Click **OK**. An Overpressure Level of Concern dialog box appears.

8. You want to know the overpressure threat for the vapor cloud explosion. Keep ALOHA's default LOCs and check that **Show confidence lines only for the longest threat zone** has been selected. Click **OK**. ALOHA will display a threat zone plot for this release.

ALOHA's threat zone window appears. None of the LOCs were exceeded for the given scenario so ALOHA does not create a threat zone plot. A vapor cloud explosion generating a dangerous overpressure is not likely to occur with the settings you chose for this scenario. (The cloud could still burn as a flash fire, but it would not generate a dangerous blast wave.) In fact, there are only a few chemicals in ALOHA's chemical library that have a high enough fuel reactivity to result in a vapor cloud explosion when the cloud is ignited by a spark or flame in an uncongested area: Acetylene; Chlorine monoxide; Ethylacetylene; Ethylene oxide; Hydrogen; 1,2 Propylene oxide; and 1,3 Propylene oxide. A vapor cloud explosion is more likely to occur if the area is congested or if the cloud was ignited by a detonation (e.g., by a high-power explosive device). Now you will model the explosion for a congested area.

```

Overpressure (Blast Force) Threat Zone

Threat Modeled: Overpressure (blast force) from vapor cloud explosion
Type of Ignition: ignited by spark or flame
Level of Congestion: uncongested
Model Run: Heavy Gas
Red : LOC was never exceeded --- (8.0 psi = destruction of buildings)
Orange: LOC was never exceeded --- (3.5 psi = serious injury likely)
Yellow: LOC was never exceeded --- (1.0 psi = breaking glass)

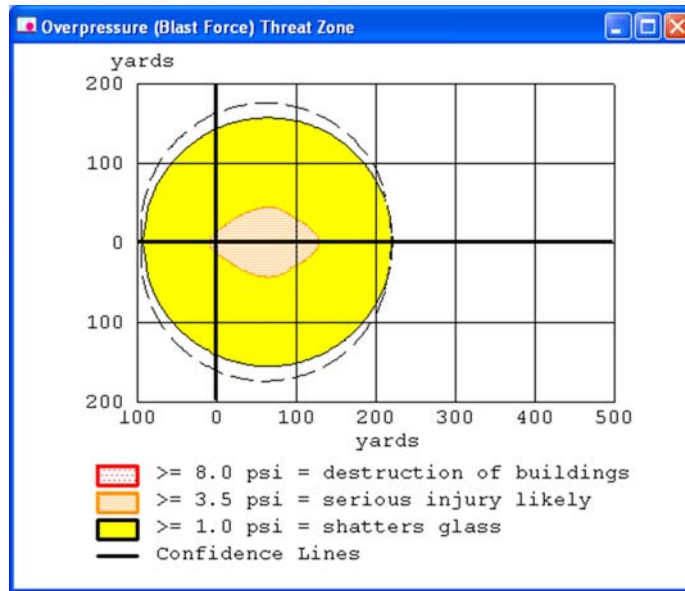
```

9. Either **print** out the Text Summary screen or paste it into a word processing document. You'll need the information to compare the scenarios later.



10. Choose **Threat Zone** from the **Display** menu. The Hazard To Analyze dialog box appears again.
11. **Blast Area of Vapor Cloud Explosion** is already selected, so click **OK**. The Vapor Cloud Explosion Parameters dialog box appears again.
12. Keep your previous settings for ignition time and ingestion type, but choose **congested** as the congestion level. Click **OK**. The Overpressure Level of Concern dialog box appears again.
13. Keep ALOHA's default LOCs and check that **Show confidence lines only for the longest threat zone** has been selected. Click **OK**. ALOHA will display a threat zone plot for this release.

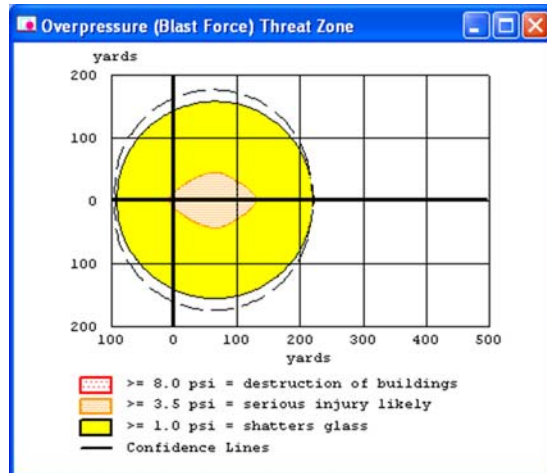
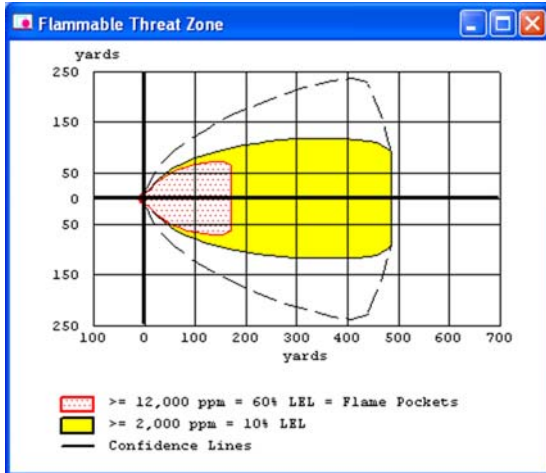
ALOHA's threat zone window appears. ALOHA has plotted the orange and yellow threat zones. A review of the Text Summary reveals that the red threat zone was not plotted because the LOC was never exceeded and that the orange threat zone is predicted to extend 129 yards in the downwind direction. Note that because you chose the unknown time option, ALOHA ran explosion scenarios for a range of ignition times encompassing all of the possible ignition times for your scenario. Therefore, these threat zones do not represent the blast area from a single explosion, but rather the composite of potential blast areas for all of the different ignition time scenarios that ALOHA ran.



```

Text Summary
-----
THREAT ZONE:
  Threat Modeled: Overpressure (blast force) from vapor cloud explosion
  Type of Ignition: ignited by spark or flame
  Level of Congestion: congested
  Model Run: Heavy Gas
  Red   : LOC was never exceeded --- (8.0 psi = destruction of buildings)
  Orange: 129 yards --- (3.5 psi = serious injury likely)
  Yellow: 221 yards --- (1.0 psi = shatters glass)
  
```

Compare the flammable vapor cloud threat zone plots. (Below, the flammable area threat zone plot is shown on the left and the congested vapor cloud explosion threat zone plot is on the right; threat distances from the Text Summary screens for all of the flammable vapor cloud scenarios are summarized in a table.)



The flammable area red threat zone is estimated to extend 171 yards downwind. This is the area where ALOHA predicts a flash fire or a vapor cloud explosion could occur at some point after the release begins—depending on the release conditions, congestion level, and availability of ignition sources. When you modeled the uncongested vapor cloud explosion, you found that a vapor cloud explosion generating a dangerous overpressure is not likely to occur and ALOHA does not display a threat zone plot. You also modeled a congested vapor cloud explosion, even though you felt the conditions were better described by the uncongested explosion. The congested vapor cloud explosion is likely to overestimate the overpressure hazard for your scenario, because it does not describe the congestion level in the majority of the cloud. The red threat zone for this explosion was not displayed because the chosen LOC was never exceeded.

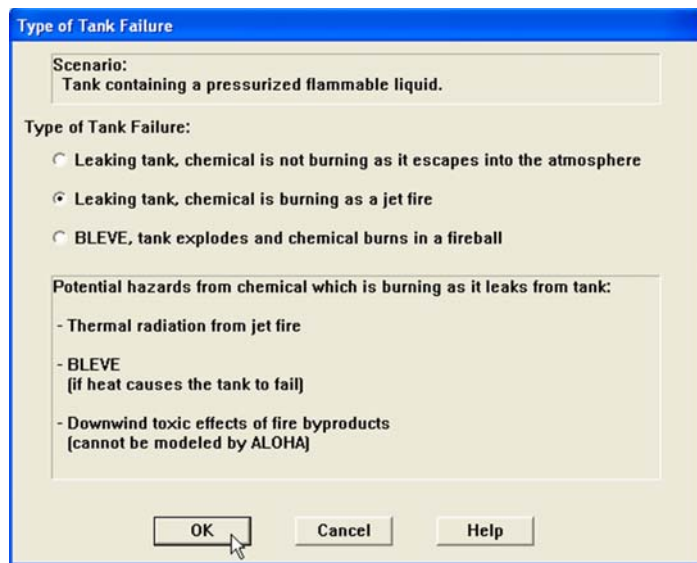
Since uncongested is the most accurate congestion level for this scenario, you decide that a vapor cloud explosion is not likely to occur. However, a flash fire could occur (regardless of the congestion level), so it is important to consider the availability of ignition sources within the flammable area of the vapor cloud.

Scenario	Threat Modeled	Red Threat Zone	Orange Threat Zone	Yellow Threat Zone
Flammable area	Thermal radiation, if a flash fire occurs	171 yards	No LOC selected	489 yards
Vapor cloud explosion (uncongested)	Overpressure	LOC never exceeded	LOC never exceeded	LOC never exceeded
Vapor cloud explosion (congested)	Overpressure	LOC never exceeded	129 yards	221 yards

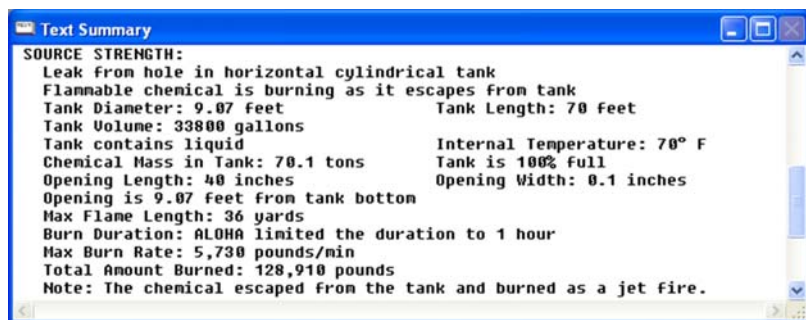
## Modeling a third scenario: jet fire

Now that you have considered the flammable area and the overpressure hazard from a vapor cloud explosion, you want to assess the thermal radiation threat if the tank leaks and the escaping propane is quickly ignited, so that a jet fire occurs instead. Therefore, you do not need to enter new information for time, atmospheric conditions, or tank size.

1. Either **print** out the threat zone plot and the Text Summary screen from the last scenario or paste them into a word processing document. You'll need the information to compare the scenarios later.
2. **Close** the threat zone plot window.
3. When you set the source for the second scenario, you told ALOHA that the tank was leaking, but the chemical was not on fire. You need to return to the Type of Tank Failure screen and tell ALOHA that now you want to model a scenario where the chemical is burning as it escapes into the atmosphere. Begin by selecting the Tank source again. In the **SetUp** menu, point to **Source**, then select **Tank**. A Tank Size and Orientation dialog box appears.
4. Your original information is still correct on the Tank Size and Orientation, Chemical State and Temperature and the Liquid Mass or Volume dialog boxes. Click **OK** on each screen until the Type of Tank Failure dialog box appears.
5. Choose the **Leaking tank, chemical is burning as a jet fire** option. Click **OK**. An Area and Type of Leak dialog box appears.
6. Your original information is still correct on the Area and Type of Leak dialog box. Click **OK** on each screen. A Height of the Tank Opening dialog box appears.
7. ALOHA models jet fires assuming the opening is on the top of the tank. Type "100" in the % of the way to the top of the leak box. Click **OK**.



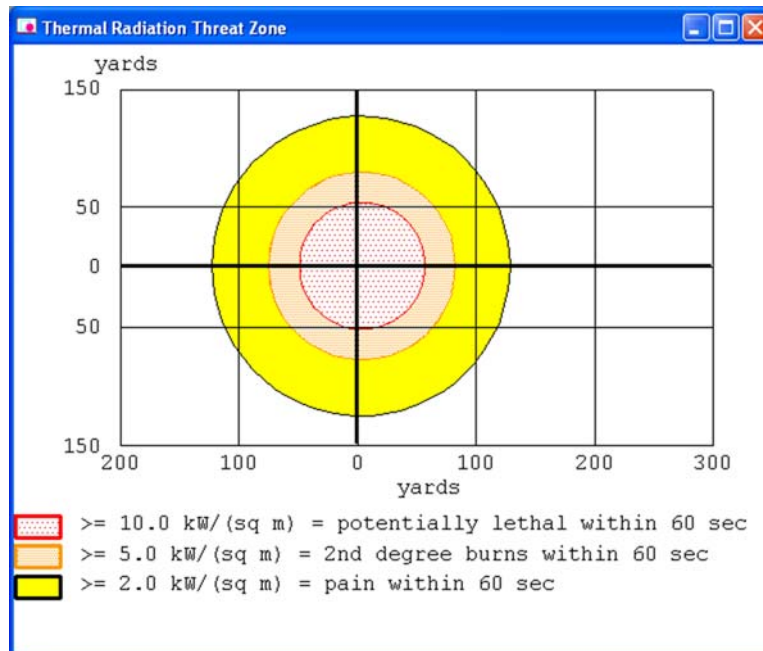
The source strength information that you have entered, and the results of ALOHA's source strength calculations, appear in the Text Summary. ALOHA limited the jet fire to one hour, and estimated that the Maximum Burn Rate is 5,730 pounds per minute.



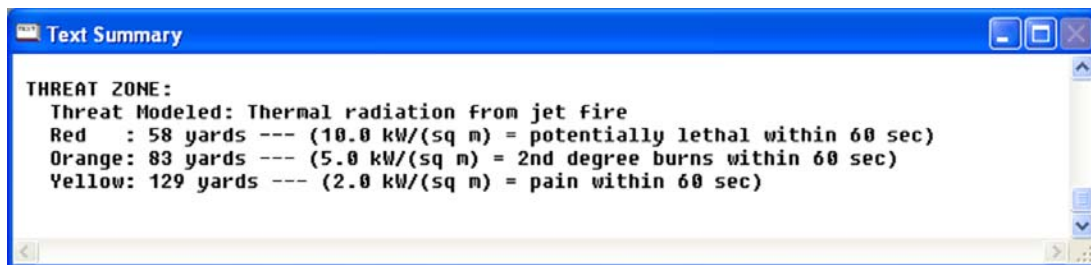
## Choosing LOCs and creating a threat zone plot for a jet fire

1. Choose **Threat Zone** from the **Display** menu. A Thermal Radiation Level of Concern dialog box appears.
2. You want to know the thermal radiation threat for the jet fire. Keep ALOHA's default LOCs and click **OK**. ALOHA will display a threat zone plot for this release.

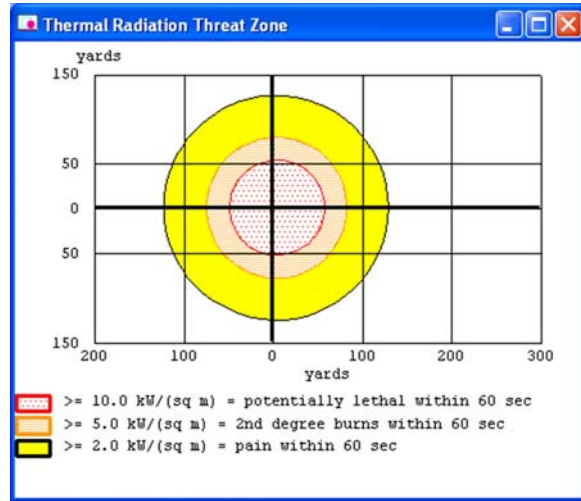
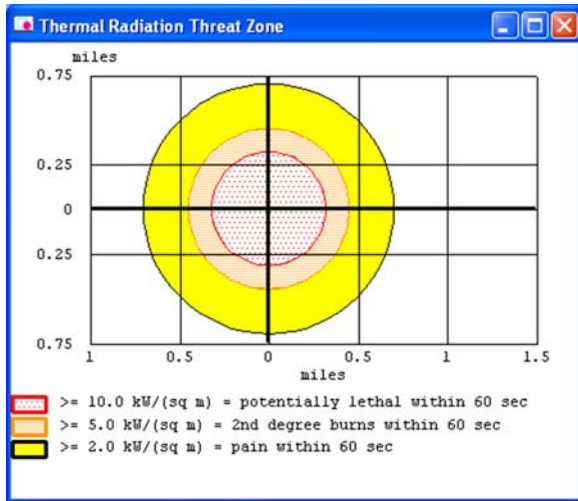
You'll see ALOHA's threat zone plot for this scenario, showing three thermal radiation threat zones. ALOHA estimates that the red threat zone—the worst hazard level—will extend about 50 yards in all directions (and a little farther in the downwind direction). The orange and yellow threat zones represent areas of decreasing hazard. It is important to realize that there may be additional hazards that are not modeled by ALOHA, including secondary fires and explosions.



Check the Text Summary for this release.



You have already compared the plots for the flammable area and the vapor cloud explosion, so now you want to compare the thermal radiation threat zone plots and the Text Summary screens from the BLEVE and jet fire scenarios (Below, the BLEVE threat zone plot is shown on the left and the threat distances from the Text Summary screens for all of the scenarios are summarized in a table.) The BLEVE red threat zone—the worst hazard level—is estimated to extend 560 yards in all directions. The jet fire red zone is only predicted to extend about 50 yards in all directions. However, the BLEVE will last about 14 seconds, whereas the jet fire is predicted to last over an hour. When considering thermal radiation hazards it is important to consider both the thermal radiation level and the length of time over which someone might be exposed to that level.



Scenario	Threat Modeled	Red Threat Zone	Orange Threat Zone	Yellow Threat Zone
BLEVE	Thermal radiation	560 yards	790 yards	1231 yards
Flammable area	Thermal radiation, if a flash fire occurs	171 yards	No LOC selected	489 yards
Vapor cloud explosion (uncongested)	Overpressure	LOC never exceeded	LOC never exceeded	LOC never exceeded
Vapor cloud explosion (congested)	Overpressure	LOC never exceeded	129 yards	221 yards
Jet fire	Thermal radiation	58 yards	83 yards	129 yards

## Example 3: A Direct Source and a MARPLOT Map

At 3 p.m. on June 4, 2006, a train traveling on the Southern Railway near Manassas, Virginia, collides with a stalled truck at Lee Highway. Three 150-pound chlorine cylinders that were in the truck bed are damaged during the collision and simultaneously release their contents. At the time of the release, winds are out of the east at about 6 miles per hour, measured at a height of 3 meters. One-third of the sky is covered by clouds, the humidity is about 80% and the air temperature is 72° F. There is no low-level inversion.

The land between the accident site and the intersection of Gallerher Road with Lee Highway is flat with no obstructions. Two workmen repairing potholes at this intersection are overcome by fumes and treated at a local hospital for chlorine gas inhalation. To what approximate concentration of chlorine might the workmen have been exposed? You'll evaluate this scenario first by using ALOHA to obtain a source strength estimate and a threat zone plot, and then by displaying the threat zones on a MARPLOT map in order to obtain a concentration estimate for the location where the workmen were injured.

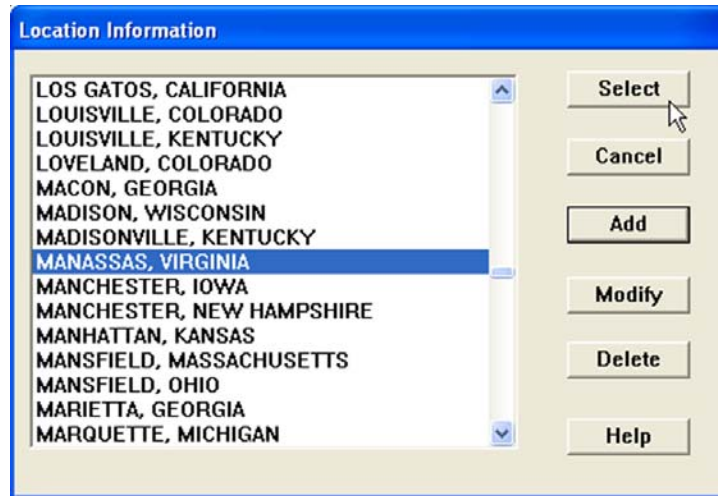
### Choosing a location and a chemical

1. Start ALOHA, or, if ALOHA is already running, select **New** from the **File** menu to begin a new scenario (you will be asked whether you wish to save a file of your previous work).
2. Read the list of ALOHA's limitations (click **Help** to see more details), then click **OK**.
3. Select **Location** from the **SiteData** menu. A Location Information dialog box appears with a list of the names of cities included in ALOHA's location library.
4. Manassas, Virginia is not a location in ALOHA's library, so you'll need to add it. Click **Add**. A Location Input dialog box appears.
5. Manassas, Virginia is a city in the United States, located at 38° 50' N and 77° 30' W, and with an elevation of 200 feet. Type "MANASSAS" in the location name box. Select the **In U.S.** option. Type "200" in the elevation box and select **ft**. Type "38" in the latitude degree box and "50" in the latitude minute box. Select **N**. Type "77" in the longitude degree box and "30" in the longitude minute box. Select **W**. Scroll through the list of states and territories until you see Virginia. (You can also click anywhere within the list, then type "v" to quickly move to that letter's location in the list). Click on **Virginia**. Click **OK**. ALOHA's list of locations will reappear.

The screenshot shows the "Location Input" dialog box. It includes the following fields and options:

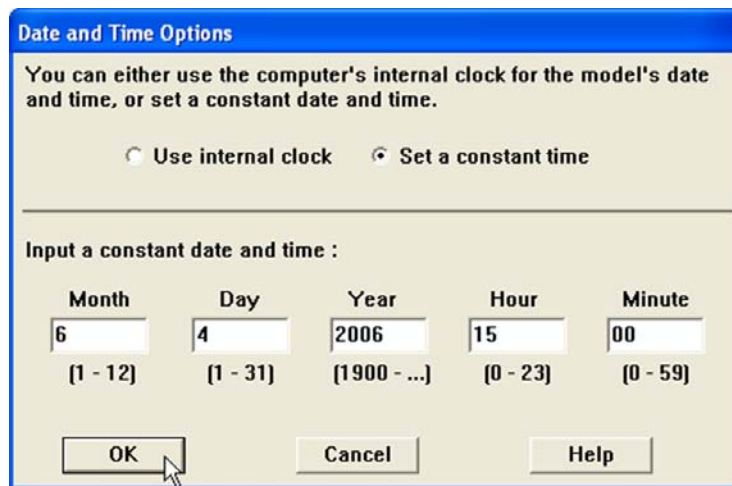
- Enter full location name:** Location is: MANASSAS
- Is location in a U.S. state or territory?**
  - In U.S.
  - Not in U.S.
- Select state or territory:** A list box containing: TENNESSEE, TEXAS, UTAH, VERMONT, VIRGIN ISLANDS, **VIRGINIA** (highlighted), WAKE ISLAND, WASHINGTON, WEST VIRGINIA.
- Enter approximate elevation:** Elevation is: 200 [ft/m]
- Enter approximate location:**
  - Latitude: 38 [deg.] 50 [min.] [N/S]
  - Longitude: 77 [deg.] 30 [min.] [E/W]
- Buttons: OK, Cancel, Help

6. Click on MANASSAS, VIRGINIA to highlight it, then click **Select**.

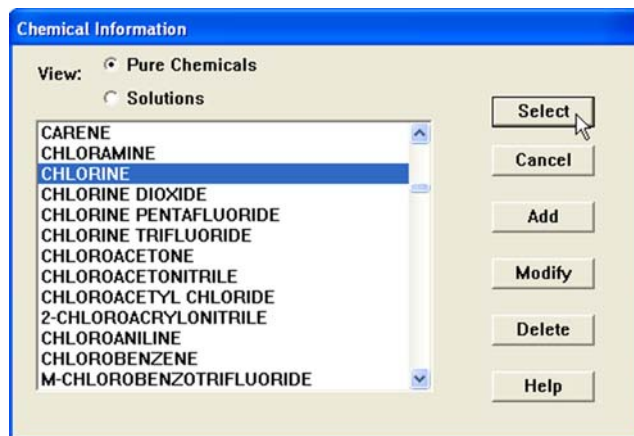


In this example, you will not modify the default building type settings because you are only interested in outdoor concentrations.

7. Select **Date & Time** from the **SiteData** menu. A Date and Time Options dialog box appears.
8. The release occurs on June 4, 2006 at 3 p.m. (1500 in 24-hour time). Select the **Set a constant time** option. Enter the month, day, year, hour and minute for this scenario (press Tab to move from one box to the next). Click **OK**.



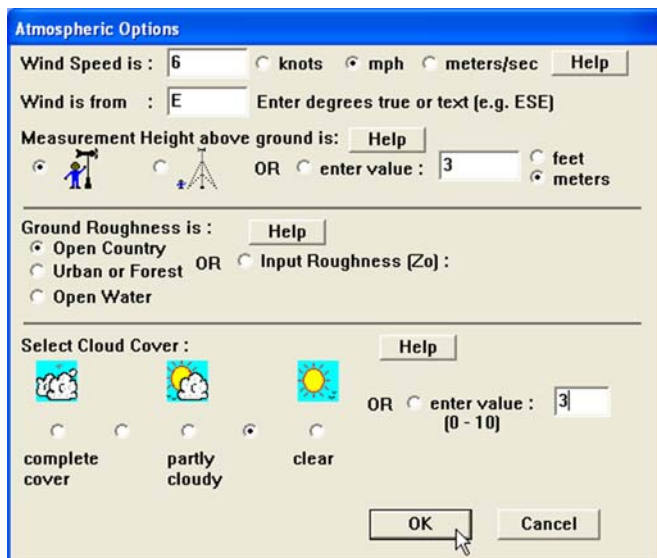
9. To choose the chemical that is being released—chlorine—select **Chemical** from the **SetUp** menu. A Chemical Information dialog box appears with a list of the chemicals in ALOHA's chemical library.
10. Check to be sure that **Pure Chemicals** is selected at the top of the window (this should be the default). Find **CHLORINE** in the list (quickly type the characters “ch” to locate chlorine more rapidly in the list), click on this name, then click **Select**.



## Entering weather information

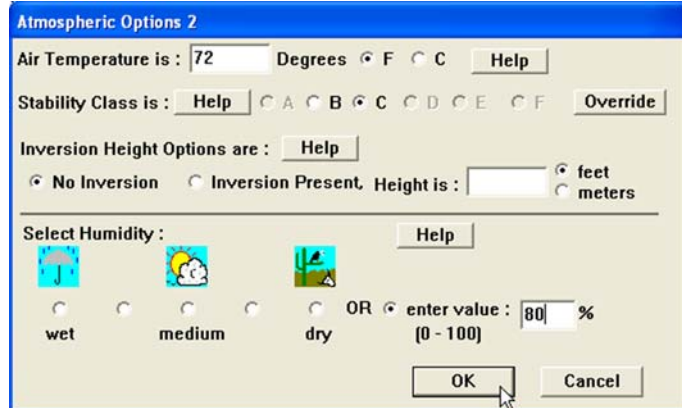
Now that you've selected the location, time, and chemical, you must provide information about weather conditions and ground roughness.

1. In the **SetUp** menu, point to **Atmospheric**, then select **User Input**. The first Atmospheric Options dialog box appears.
2. The wind is travelling from the east at a speed of 6 miles per hour. Type “6” in the wind speed box, then select **mph**. Type “E” in the wind direction box.
3. The wind conditions were measured at a height of 3 meters. Type “3” in the measurement height value box, and select **meters**.
4. The area between the accident site and the injured workmen is flat and free of obstacles, so select the **Open Country** ground roughness option.
5. The sky is one-third covered. Under Select Cloud Cover, choose the fourth option from the left (the option between the partly cloudy and clear options). Notice that ALOHA has filled in a value of 3. Click **OK**. The second Atmospheric Options dialog box appears.

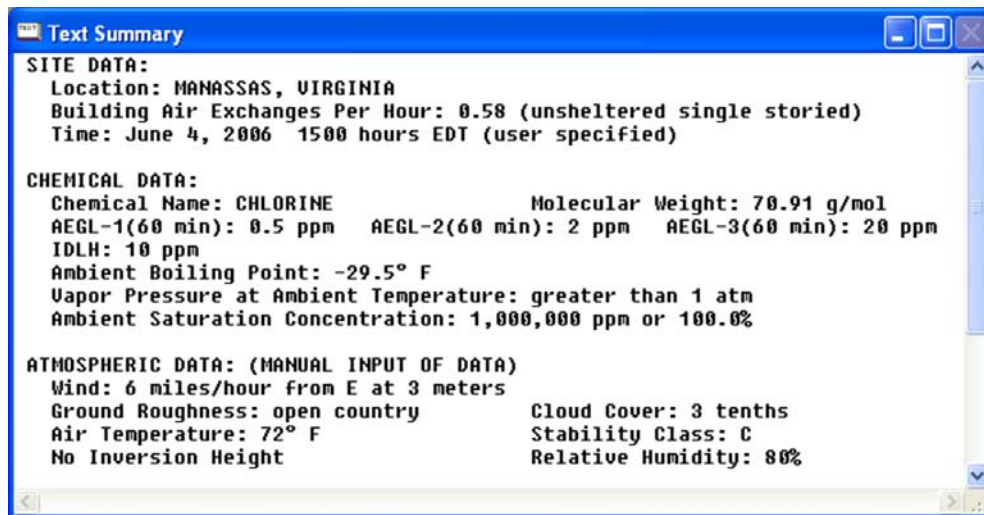




6. The air temperature is 72°F. Type “72” in the air temperature box, then select **F**.
7. ALOHA uses the wind speed, cloud cover, and date and time information that you’ve entered to automatically select atmospheric Stability Class C.
8. There is no low-level inversion. Check to be sure that **No inversion** is selected.
9. The relative humidity is about 80 percent. Type “80” in the humidity value box. Click **OK**.



The information that you have entered into ALOHA appears in the Text Summary. Review the Text Summary to be sure you have entered all of the data correctly.



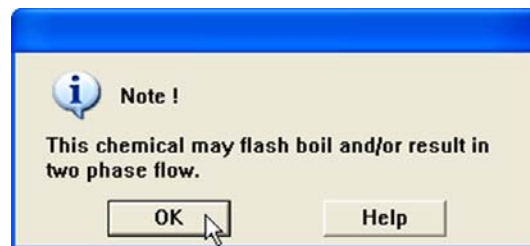
## Describing the release

Now you’re ready to enter information about the release itself—that is, to “set the source”—for this release. This is a release from three cylindrical tanks, but you don’t have all the information that you would need to model the release with ALOHA’s Tank source option. You can model this release as a Direct source, however.

1. In the **SetUp** menu, point to **Source**, then select **Direct**. A Direct Source dialog box appears.

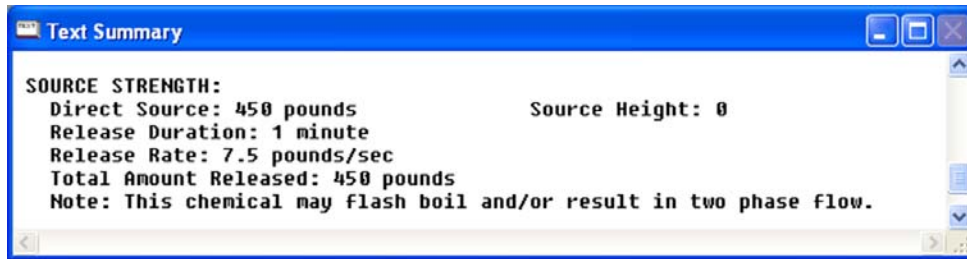
2. Three 150-pound chlorine cylinders that were in the truck bed are damaged during the collision and simultaneously release their contents. Select **pounds** as your units of source strength. This is an instantaneous release, so select **Instantaneous source**. Because the chlorine is released simultaneously, you can model the release from all three tanks as a single release. Type “450” into the amount box. The truck bed is roughly at ground level, so type “0” in the source height box. Click **OK**.

3. ALOHA will alert you that the chemical may flash-boil and/or escape as a two-phase flow.



Click **Help** to view background information about flash-boiling and two-phase flow. ALOHA recognizes that because the boiling point of chlorine is well below air temperature, the chlorine may have been stored as a liquefied gas. If so, it may flash-boil when released through a hole in a tank. During flash-boiling, much of the stored liquid would turn instantly to vapor, so that a mixture of liquid droplets and vapor (a “two-phase flow”) would be released to the atmosphere. ALOHA’s Tank source release calculations account for these processes, but the Direct source option does not. Since you don’t have the necessary information to run the Tank option, you’ll use the Direct source calculations as the best approximation that you can make, recognizing that ALOHA will treat this release as a steady flow of gas from the tank instead of a time-dependent release (a release where rate varies over time). Click **OK**.

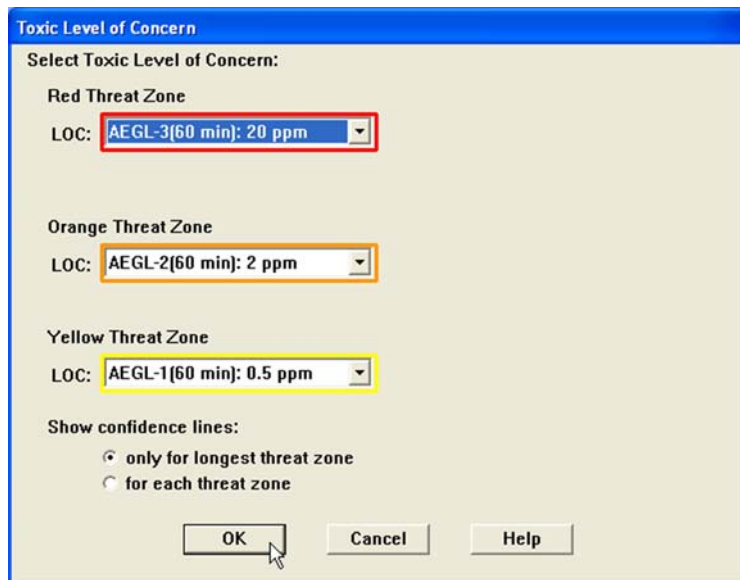
The source strength information that you have entered into ALOHA and the results of ALOHA's computations appear in the Text Summary.

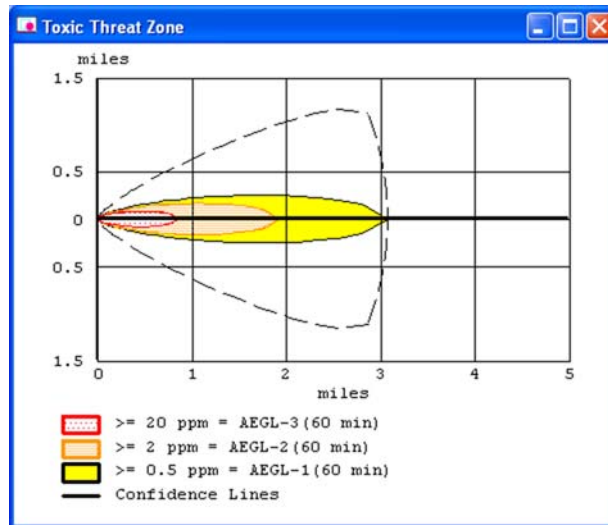


### Choosing LOCs and creating a threat zone plot

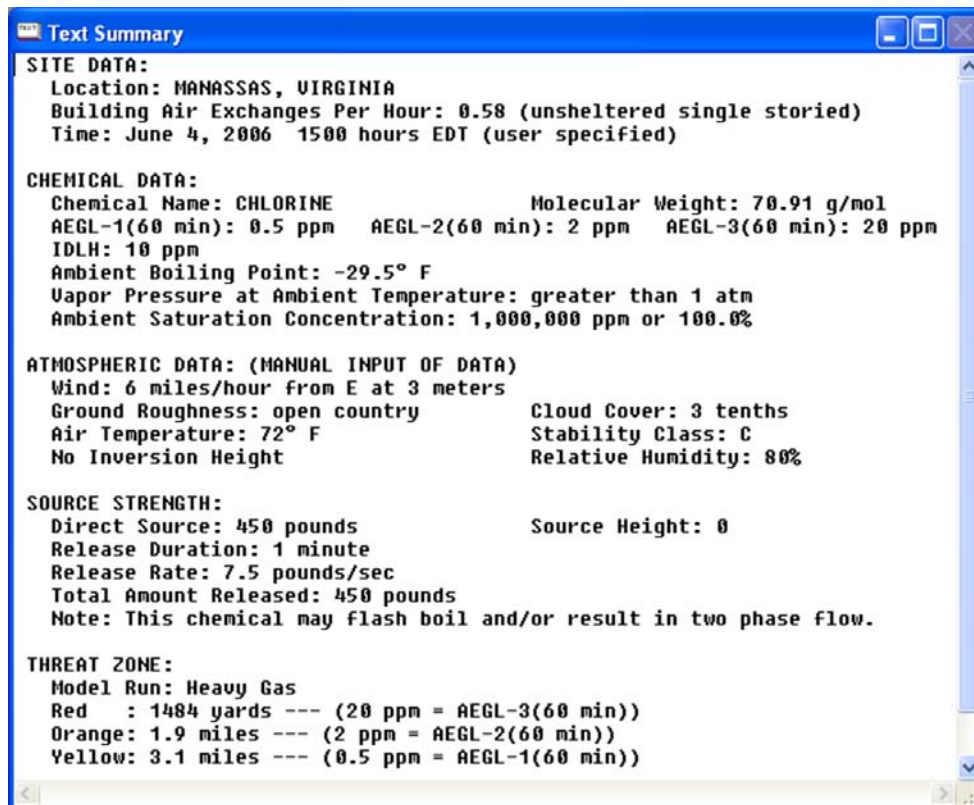
Now that you've entered all of the release information, you can display the results of ALOHA's threat zone calculations.

1. Choose **Threat Zone** from the **Display** menu. A Toxic Level of Concern dialog box appears.
2. ALOHA uses 60-minute AEGLs (Acute Exposure Guideline Levels) as the default Levels of Concern (LOCs) for chlorine. Keep the default LOCs and check that **Show confidence lines only for the longest threat zone** has been selected. Click **OK**. ALOHA will display a threat zone plot for this chlorine release.





Check the Text Summary to see the lengths of the three threat zones. For example, ALOHA expects the red threat zone, which exceeds the AEGL-3 (20 ppm) value, to extend at least 1,484 yards downwind.



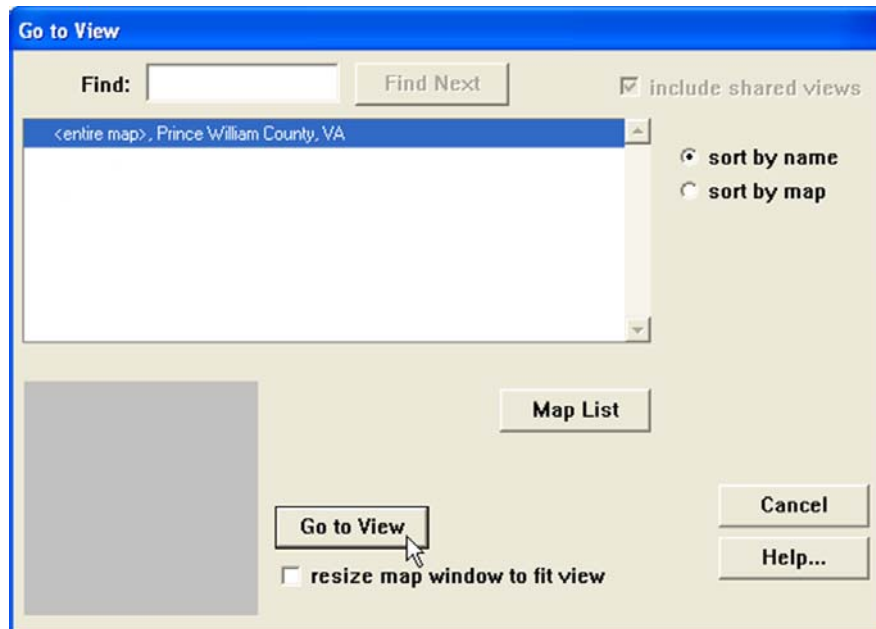
## Using MARPLOT

Now you are ready to plot ALOHA's threat zone estimates on a map of the area in MARPLOT, and to obtain a concentration estimate for the workmen's location.

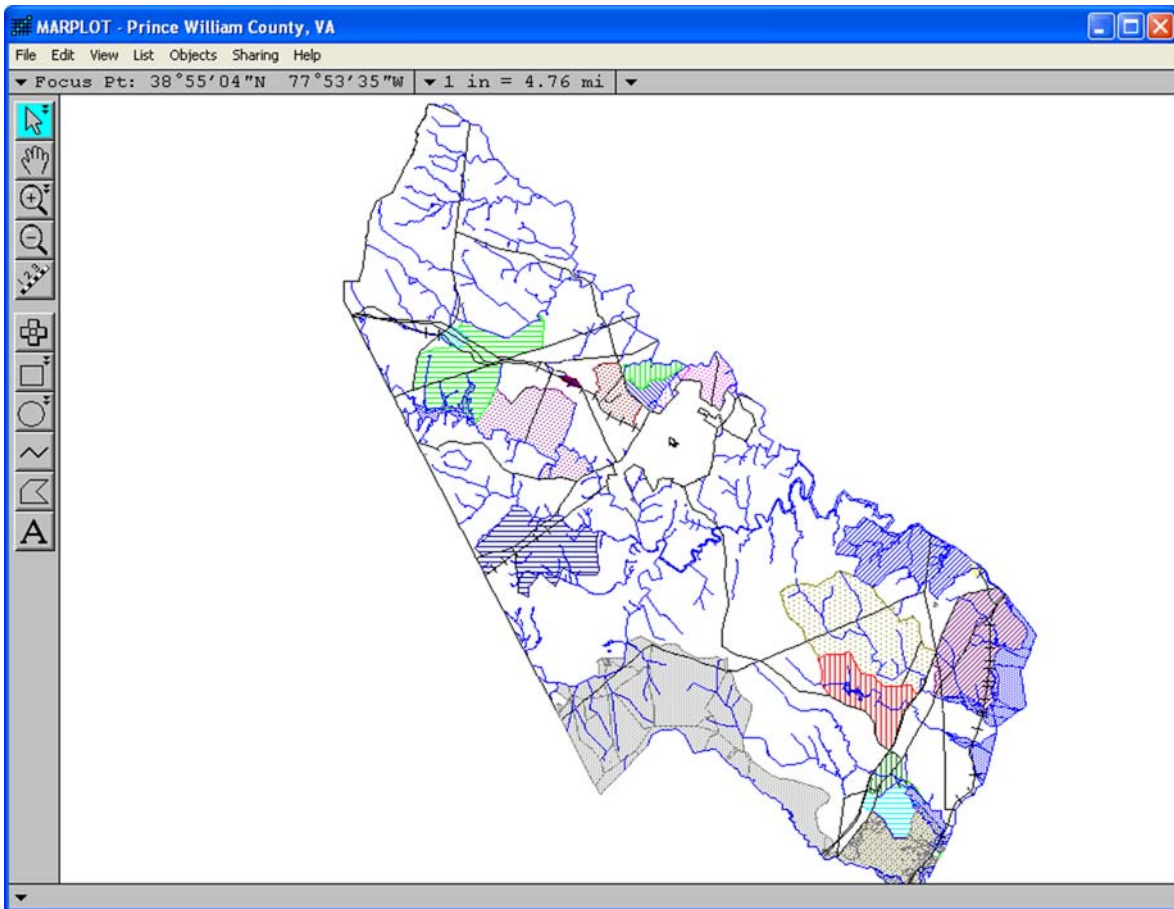
1. Select **Go to Map** from the **MARPLOT** submenu under ALOHA's **Sharing** menu to start MARPLOT.



2. If this is the first time you've used MARPLOT, the Prince William County, VA map should automatically be displayed. If it is not, then select **Go to View** from **MARPLOT's View** menu. A Go to View dialog box appears.
3. Click to highlight **<entire map> Prince William County, VA**, then click **Go to View**.

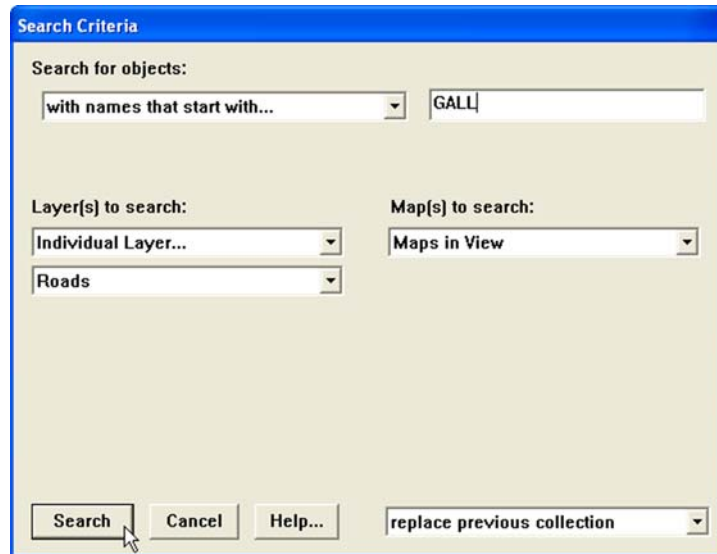


The Prince William County, VA map will then be displayed.

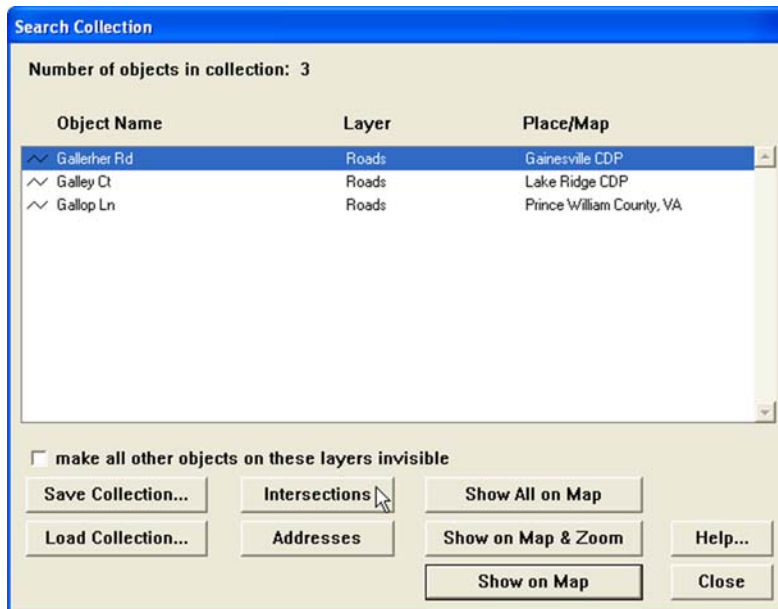


4. Now you'll search on the map for the location where the accident occurred. Choose **Search** from the **List** menu. A Search Criteria dialog box appears.

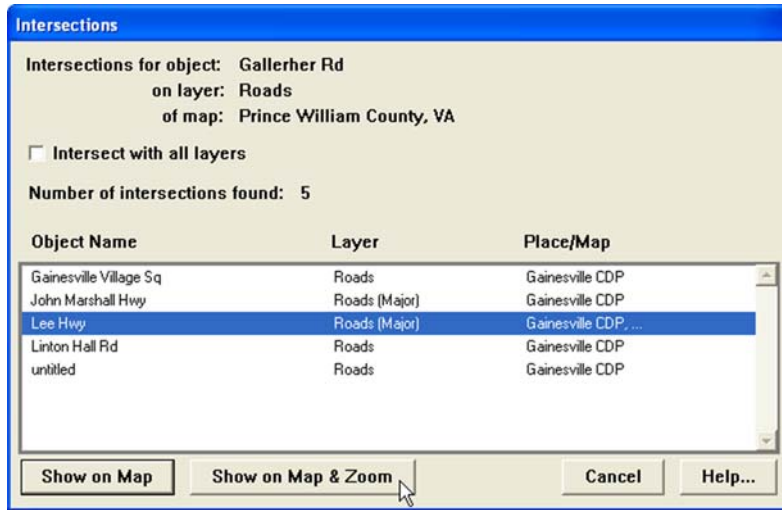
- The workmen are working at the intersection of Gallerher Road with Lee Highway. To search for Gallerher Road, type “GALL” in the box next to the search “with names that start with...” box. Make sure that **Individual Layer** has been selected in the menu just below the “Layer(s) to search:” heading, then select **Roads** from the pulldown menu below that. Check to be sure that **Maps in View** is selected in the menu below the “Map(s) to search:” heading. Click **Search**. A Search Collection dialog box appears.



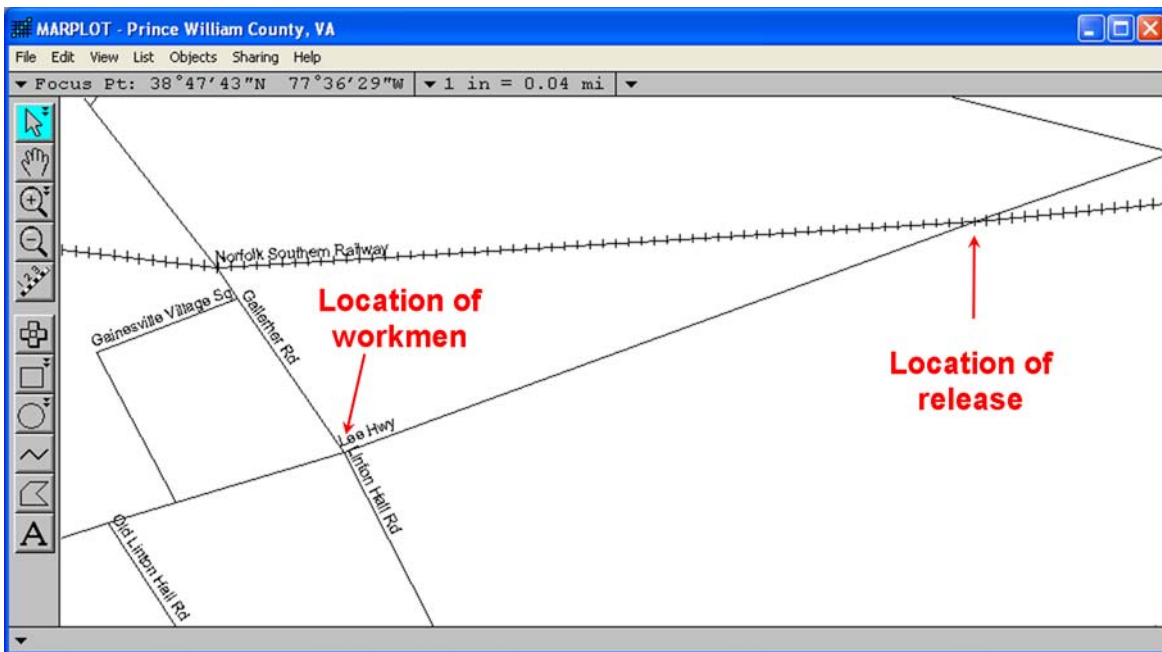
- The search collection includes three roads. Click once on **Gallerher Rd** to highlight it, then click **Intersections**. An Intersections dialog box appears.




- There are five intersections along Gallerher Road. Click to highlight **Lee Hwy** in the list, then click **Show on Map & Zoom**.

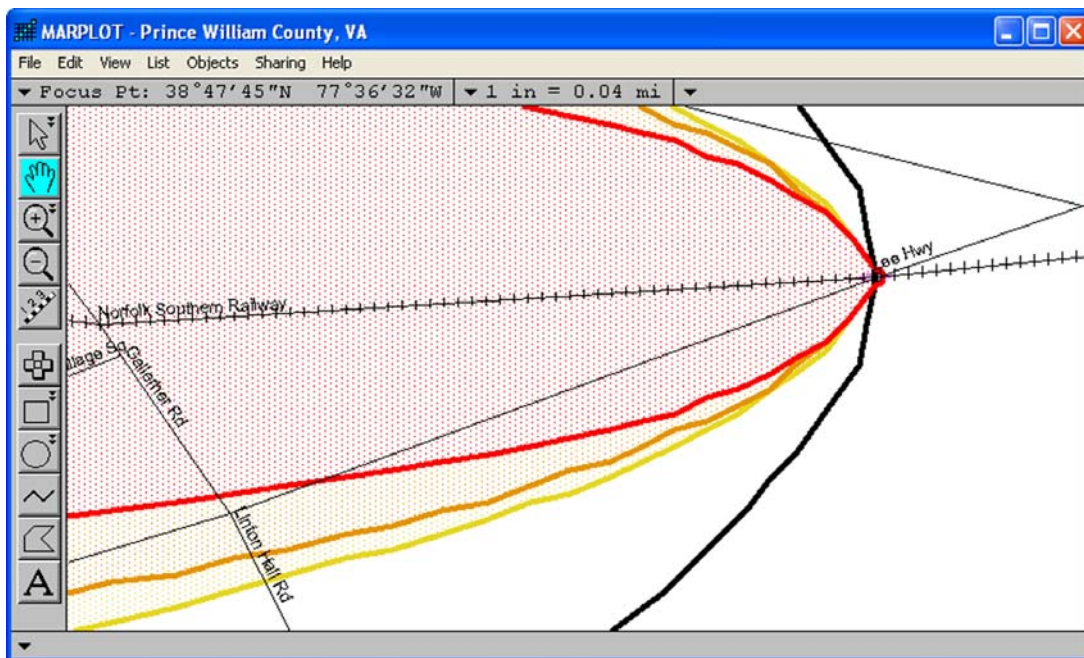
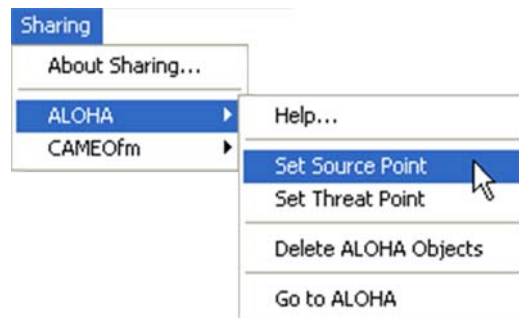


A map similar to the one below appears. Lee Hwy crosses the map as a straight line from the lower left to the upper right of the map. The Southern Railroad crosses the map horizontally, and intersects with Lee Hwy near the right side of the map. (Your map may look different than this one, depending on the display settings you have chosen.)



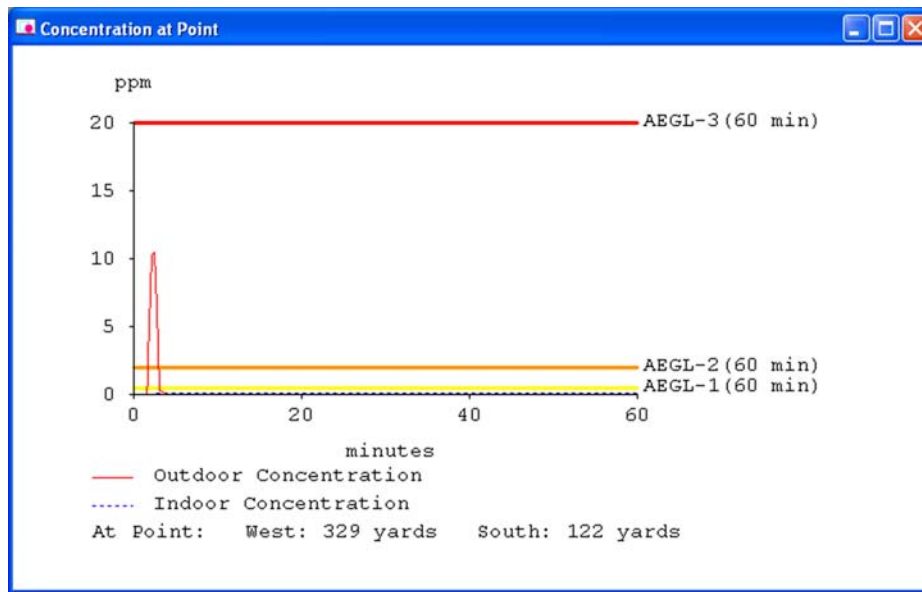


8. In this example, the chlorine is released at the point where the Southern Railway line crosses Lee Highway. To indicate this location, choose the arrow tool  from MARPLOT's tool palette, then click once at this intersection. MARPLOT will place a visible crosshair mark, or "click point" at this location.
9. In MARPLOT's **Sharing** menu, select the **ALOHA** submenu, then click **Set Source Point**. ALOHA's threat zone estimates will automatically be drawn on the map.

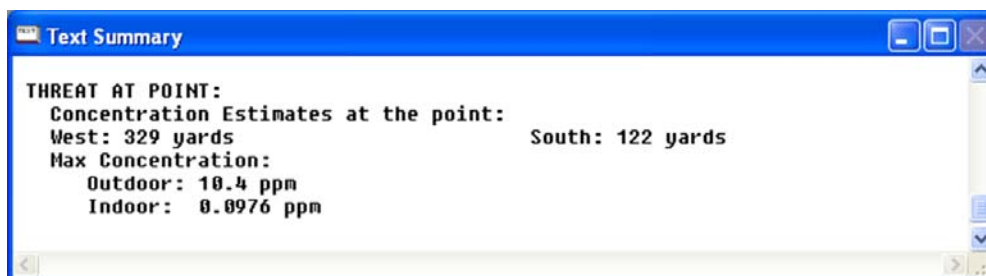


**Note:** The colors of the threat zones may differ in older versions of MARPLOT.

10. Now you want to estimate the concentration level where the workers were exposed (at the intersection of Gallerher Road and Lee Highway). Find the intersection (this is just outside of the red threat zone). Select the arrow tool in the tool palette, then click on this location.
11. In MARPLOT's **Sharing** menu, select the **ALOHA** submenu, then click **Set Threat Point**. The ALOHA window will come to the front and it will display a Concentration at Point graph for this location (threat at point). Review the graph and the Text Summary. ALOHA estimated that the workmen were exposed to an outdoor concentration above the AEGL-2 level for roughly three minutes. **Note: Your graph may differ slightly from the one below if you click on a slightly different point on the map when setting your threat point.**



Don't be concerned if the numbers that you see on your screen differ slightly from those shown in the Text Summary. ALOHA's estimates are affected by exactly where on the map you click. The purpose of running this scenario in ALOHA and MARPLOT was to get an estimate of the concentration of chlorine to which the workmen were exposed.



ALOHA was designed to give you “ballpark” estimates of source strength and dispersion. It cannot give you completely accurate predictions for a real release, because no model can account for every uncertainty. For example, ALOHA predicted that the workmen were exposed to a concentration of about 10 ppm of chlorine for only a few minutes. However, if the wind shifted during the course of the release, the concentration at the workmen’s location could have been higher or lower than ALOHA’s estimate. If you were to respond to a real event similar to this example, you might wish to obtain values for the tank’s dimensions, the size and location of the hole, and other information that you’d need to run ALOHA’s Tank source option, which takes time-dependent release rates into account.

12. When you’ve finished this example problem, simply choose **Exit** (in Windows) or **Quit** (on a Macintosh) from **MARPLOT’s File** menu. ALOHA’s threat zones will then be deleted from the map.

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# Reference

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Refer to this chapter for detailed explanations of ALOHA program operation, features, and menu items. The sections of this chapter correspond to ALOHA's menus.

## File menu

### New

Choose **New** to clear all information about a scenario from ALOHA before beginning a new scenario. When you choose this menu item, you have the option of saving your old scenario before clearing ALOHA.

### Open

Choose **Open** to open a previously saved ALOHA file. Whenever you open a saved file within ALOHA, you can choose between two modes: **Response Mode** or **Planning Mode**.

**Response Mode.** Choose this mode when you open a saved file in order to use ALOHA during a real emergency. As ALOHA opens the file, it will restore the information contained in the file that is expected to stay the same from day to day. This information includes location, chemical of concern, and the dimensions of existing storage vessels and containment areas. You'll need to enter information specific to your incident, including current weather conditions and the circumstances of the release (these could include, for example, the dimensions and location of a hole in a tank, or the area of a puddle of spilled liquid).

**Planning Mode.** Choose this mode when you want to look at a saved scenario again—with all of the same input values as at the time it was saved. If you were using the computer's clock to set the time, ALOHA will use the time when the file was saved as the constant time. If you were using a portable weather monitoring station (SAM), the most recent transmission will be entered into ALOHA as user-entered atmospheric data.

Saved files created from the current version of ALOHA are cross-platform: you can open a save file created in Microsoft Windows on a Macintosh computer, and vice versa.

File	
New	Ctrl+N
Open...	Ctrl+O
<hr/>	
Close	Ctrl+W
Save	Ctrl+S
Save As...	
<hr/>	
Print...	Ctrl+P
Print All...	
Print Setup...	
<hr/>	
Exit	Alt+F4

## Close

Choose **Close** to close ALOHA's front window. However, you cannot close the Text Summary window.

## Save and Save As

Choose **Save** or **Save As** when you want to save the results of your work in a data file.

Do this if you wish (a) to prepare in advance for an incident response by creating a set of saved ALOHA files or (b) to be able to rerun a scenario in the future. If you modified property information about a selected chemical while setting up a scenario, you can save this information in a saved file without making a permanent change to the chemical library. When you open and use a saved file in ALOHA in planning mode, all the information in the file will be restored. When you open and use a saved file in ALOHA in response mode, you'll still need to enter information specific to a particular release, such as weather conditions and the amount of material released, before you can obtain a source strength estimate or threat zone plot.

## Print, Print All, and Print or Page Setup

Choose **Print** to print the contents of the front ALOHA window. Choose **Print All** to print the contents of all active ALOHA windows. Choose **Print Setup** in Windows (or **Page Setup** on a Macintosh) to choose the printer and other print options.

## Quit or Exit

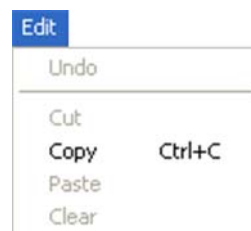
Choose **Quit** (on a Macintosh) or **Exit** (in Windows) to exit ALOHA. To save the scenario you have been working with, select **Save** or **Save As** from the **File** menu before exiting from the program.

## Edit menu

### Copy

Choose **Copy** to copy pictures or selected text from the front window to the clipboard. You can then paste copied items into a word processing or graphics application.

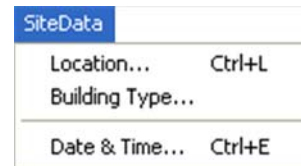
The **Undo**, **Cut**, **Paste**, and **Clear** menu items are not available in ALOHA.



## SiteData menu

The SiteData menu is the first menu in ALOHA that you use to enter information about a release scenario. Use the three items in this menu to enter information about:

- The geographic location of the chemical release;
- The type of buildings in the area downwind of a toxic chemical release; and
- The date and time of the release.



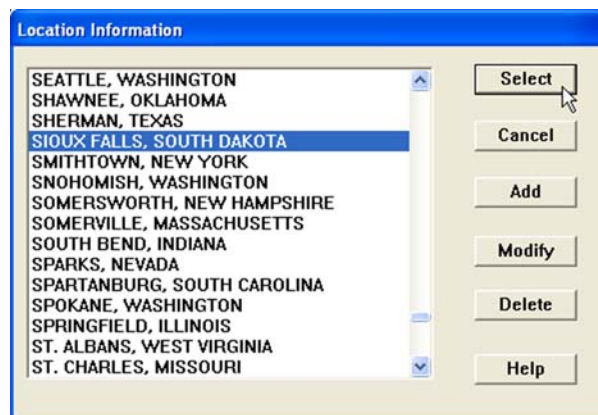
### Location

Choose this item to specify the geographical location of a release. ALOHA uses the latitude, longitude, elevation, and time zone of the location of a chemical release in some of its computations. This information, for many cities and towns where ALOHA users reside, is already included in ALOHA's location library (CityLib). You can add descriptions of other locations. ALOHA uses location information to estimate:

- Sun angle (ALOHA uses latitude, longitude, and time of day for this calculation); and
- Atmospheric pressure (determined by the location's elevation).

The angle of the sun is important when a chemical has formed a puddle on the ground that is evaporating. ALOHA calculates the amount of energy coming into the puddle from the atmosphere and from the ground. For example, if the sun is high in the sky (around noon), the amount of energy coming into the puddle is greater than it would be in the early morning or late afternoon, when the sun is lower. The more energy coming in, the higher the evaporation rate.

**Selecting a location.** To specify the location where a release is occurring, select **Location** from the **SiteData** menu. You'll see a scrolling, alphabetical list of cities (mostly U.S. cities and towns). Scroll through the list (to speed your search, type the first one or two letters of the city name), click on the city name, then click **Select**.



### Adding, modifying, and deleting location information

You can add a new city or other geographic location to ALOHA's library of cities (CityLib). You can add both U.S. and non-U.S. locations to the library. For a location outside of the U.S., you must manually change the time setting whenever time at the location switches between daylight savings and standard time.

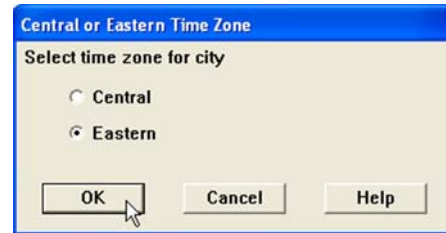
Be as accurate as you can when entering information about a location; ALOHA uses your values for elevation, latitude, and longitude to calculate solar radiation and air pressure. However, small errors in location information don't affect the accuracy of ALOHA's predictions. An estimate is accurate enough if it is within a degree or so in latitude and longitude and a few hundred feet in elevation of the actual site.

**Adding information about a U.S. city.** Choose **Location** from the **SiteData** menu to access the list of locations. Click **Add**. In the dialog box that appears, type the location's name, approximate latitude and longitude, and elevation, then click on the name of its state or territory in the scrolling list of U.S. states and territories on the right side of the window (click anywhere within the list, then type the first letter of the state or territory name to quickly move to that letter's location in the list). ALOHA checks that the information you have entered is within the range of reasonable values for the state or territory that you select. (If you have entered a value that is not in this range, ALOHA will tell you which value is out of range; you must correct your value before continuing.) Click **OK**.

The screenshot shows the 'Location Input' dialog box. The title bar reads 'Location Input'. The main area contains the following elements:

- Enter full location name:** A text box containing 'Jupiter'.
- Is location in a U.S. state or territory?** Two radio buttons: 'In U.S.' (selected) and 'Not in U.S.'.
- Enter approximate elevation:** A text box containing '50', followed by radio buttons for 'ft' (selected) and 'm'.
- Enter approximate location:**
  - Latitude:** Two text boxes for 'deg.' (26) and 'min.' (57), followed by radio buttons for 'N' (selected) and 'S'.
  - Longitude:** Two text boxes for 'deg.' (80) and 'min.' (08), followed by radio buttons for 'E' and 'W' (selected).
- Select state or territory:** A list box containing the following states and territories: ALASKA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, CONNECTICUT, DELAWARE, DIST OF COLUMBIA, and FLORIDA. 'FLORIDA' is highlighted.
- Buttons:** 'OK', 'Cancel', and 'Help' buttons are located at the bottom.

Unless the location is in a state with multiple time zones, ALOHA automatically recognizes the location's time zone, and also adjusts time of day for daylight savings when necessary. ALOHA "knows" which states are located in each U.S. time zone. However, 11 U.S. states extend across more than one time zone. When you add a new city in any of these states to ALOHA's city library, you may need to indicate the time zone in which the city is located, if it is close to a boundary between time zones. If the city is not located near a time zone



boundary, ALOHA will not display this dialog box. States with multiple time zones are: Idaho, Indiana, Kansas, Kentucky, Michigan, Nebraska, North Dakota, Oregon, South Dakota, Tennessee, and Texas.

Once you've clicked OK, the name of the new location should appear highlighted in the location list. To save your information and select the location from the list, click **Select**. If you click **Cancel** now, the information about the location that you just entered will not be added to the location library, and the city name will be removed from the list.

**Adding a location outside the U.S.** Choose **Location** from the **SiteData** menu to access the list of locations. Click **Add**. In the dialog box that appears, type in the name of the location. Don't include its country name (you'll be asked for that later). Select **Not in U.S.** Type the location's approximate elevation, latitude, and longitude, then click **OK**.

Next, you'll see the **Foreign Location Input** dialog box. Type the country name, then the number of hours that local standard time at the location differs from Greenwich Mean Time (GMT). This time offset value should be positive if the location is in the western hemisphere (North and South America), and negative if it's in the eastern hemisphere (Europe, Africa, Asia, and Australia).



Click the appropriate button to indicate whether standard or daylight savings time is currently in effect at this location. ALOHA automatically switches the time setting for U.S. cities from Standard to Daylight Savings Time (using the date on your computer's clock), but it does not automatically make this change for locations outside the U.S. Be sure to change the time setting manually whenever time at a non-U.S. location switches between daylight savings and standard time. Once you have entered all necessary information about a new location, click **OK**. Click **Select** to add the location to the library. Click **Cancel** only if you decide not to add the location to the library.

**Modifying a location.** You can modify the description of a city or other location in the city library. You can modify the location name, its approximate latitude and longitude, its average elevation above sea level, the state, territory, or country where it exists, the local time setting, and the GMT offset if it's a non-U.S. location. To change information that you've already entered for a location, choose **Location** from the **SiteData** menu to access the list of locations. Click on its name in the location list, then click **Modify**. You will see the information about that location that is currently in the location library. Delete the information that you wish to change, then type in the new value. Click **OK**.

**Deleting a location.** To remove a location from the list, choose **Location** from the **SiteData** menu to access the list of locations. Click on its name in the location list, then click **Delete**. Click **Cancel** to avoid deleting the location; click **OK** to delete the location from the list.

If you accidentally click **OK** to delete the wrong city, once you've returned to the Location dialog box, click **Cancel**. If instead you click **Select** to close this dialog box, the city will be deleted.

## Building Type

For toxic gas dispersion scenarios, ALOHA can estimate the pollutant gas concentration within buildings downwind of a chemical release. (**Note: This setting cannot be used in fire and explosion scenarios.**) You first must specify the building type of concern, which could be either the type of building that is most common in the area downwind of the release point, or the type that you are most concerned about. Indicate whether the building is single- or double-storied or is an enclosed office building. You also must indicate whether it is relatively sheltered or unsheltered from the wind by trees, buildings, or other obstacles to the wind. ALOHA expects pollutant concentrations to build up faster within single-storied rather than double-storied buildings and faster within unsheltered rather than sheltered buildings.

To estimate indoor pollutant concentration, ALOHA first estimates the building's *air exchange rate*—that is, the number of times per hour that the volume of air within the building is completely replaced by new outdoor air when doors and windows are closed. This rate is less than 1.0 if it takes more than an hour to completely change the air within the building. You also can choose to enter a value for air exchange rate, rather than specifying a building type, if you have this information. **To estimate infiltration rate into a building, ALOHA assumes that all doors and windows are closed.**

Whether you specify building type to be (a) a single- or double-storied building or (b) an enclosed office building makes a big difference in how ALOHA chooses an exchange rate value.

For single- and double-storied buildings, ALOHA accounts for the effects of wind speed and temperature to compute air exchange rate. ALOHA expects a building's air exchange rate to increase if the wind speed increases, because a faster wind exerts more force to push air through the small openings in a building's walls. The degree of difference between indoor and outdoor air temperature also affects ALOHA's air exchange rate estimate (ALOHA assumes the temperature within the building to be 68°F, or 20°C). The greater the temperature difference, the higher the air exchange rate, regardless of whether the air within the building is warmer or cooler than the outside air (this is because air masses of different temperatures have different pressures, and pressure differences stimulate air movement). The higher a building's air exchange rate, the faster the concentration of a toxic gas is predicted to rise within the building. To estimate exchange rate, ALOHA assumes that single- and double-storied buildings are about as leaky as typical North American houses that have been studied by researchers (Wilson 1987).

For enclosed office buildings, ALOHA uses a constant air exchange rate of 0.5, regardless of wind speed and air temperature. This is because the environment within a large, modern, enclosed building is controlled and kept nearly constant, regardless of weather conditions, using a heating, ventilating, and air-conditioning (HVAC) system. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends that air exchange rates for buildings be kept within the range of 0.5 to 1.0 complete changes per hour to maintain air quality.

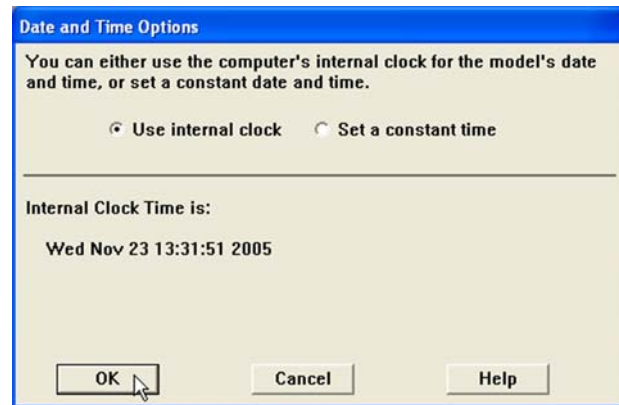
If you know a building's air exchange rate (the number of times per hour that the total air volume within the building is replaced), type this number next to **No. of air changes**. You also can adjust this number to compare the effects of different air exchange rates on indoor infiltration of a pollutant gas.

When you specify single- or double-storied building type, you also must indicate whether the building is sheltered or unsheltered. Pollutant gases infiltrate more slowly into sheltered than unsheltered buildings of the same type. Below is a decision aid for choosing between sheltered or unsheltered surroundings.

Surrounding Features	Selection Choice
If the buildings are surrounded by trees, bushes, or other buildings in the direction from which the chemical cloud will be coming.	<b>Sheltered surroundings</b>
If the buildings are in an open space, with nothing near them.	<b>Unsheltered surroundings</b>
If you don't know about the surrounding features, or if you are unsure.	<b>Unsheltered surroundings</b>

## Date & Time

Choose **Date & Time** from the **SiteData** menu to specify the date and time for ALOHA to use as the starting time of your scenario. You may choose either to enter a specific time, or to have ALOHA take the time from your computer's internal clock. **When you use the internal clock option, you will need to set your computer's clock to the local time where a release has occurred.** For example, if you are running ALOHA in Seattle for an incident taking place in Miami, set your clock to the current Miami time.

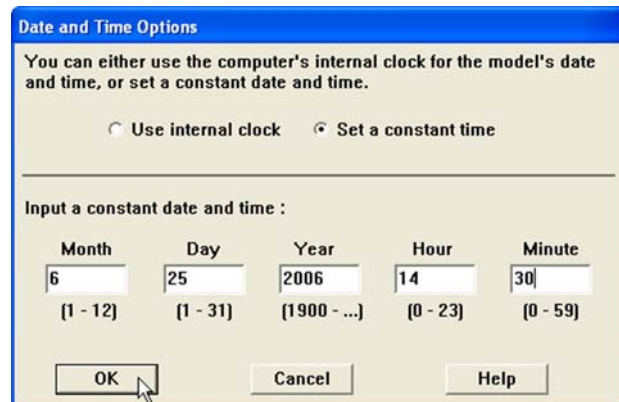


The starting time of a scenario affects ALOHA's calculations in two ways: (1) ALOHA uses the scenario start time to determine whether it is night or day when choosing a stability class, and (2) ALOHA uses the position of the sun at the scenario start time to estimate incoming solar radiation. Solar radiation can be an important influence on puddle evaporation. Whenever you use your computer's clock, the scenario starting time will be updated to the current time whenever you enter atmospheric information, change location, or choose the Date & Time menu item.

To specify date and time, choose **Date & Time** from the **SiteData** menu, then select either:

- **Use internal clock** to use your computer's internal clock; or
- **Set a constant time** to set a specific time when you want a scenario to begin. Type in the month, day, year, hour, and minute. This option is useful for contingency planning or training exercises because you can set up scenarios to run at different times of the day and/or year (and therefore under different atmospheric conditions).

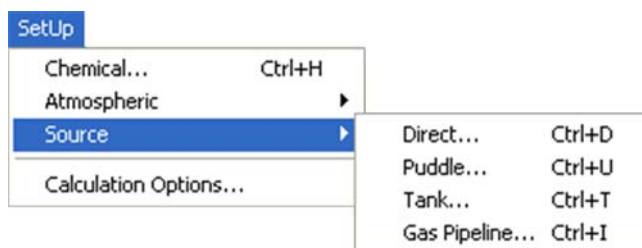
ALOHA uses the 24-hour time system, in which time of day is indicated by four digits. The first two digits indicate the hour (00 to 23) and the last two indicate the number of minutes past that hour (00 to 59). Each day begins at midnight, 0000, and the last minute of each day is 2359. Under this system, 6:00 a.m. is 0600, and 2:30 p.m. is 1430.



## SetUp menu

As you enter information into ALOHA about a release scenario, you'll move on to the **SetUp** menu after you've completed your work with the **SiteData** menu. Choose items from this menu to select a chemical from ALOHA's chemical library, describe weather conditions, and explain how the chemical is escaping from containment. You also can specify how you want ALOHA to predict the dispersion of the pollutant cloud in the atmosphere for dispersion scenarios—that is, for toxic gas dispersions, flash fire flammable areas, and vapor cloud explosions.

Select items from the SetUp menu in descending order as you describe a scenario: first select **Chemical**, then **Atmospheric**, and finally **Source**.

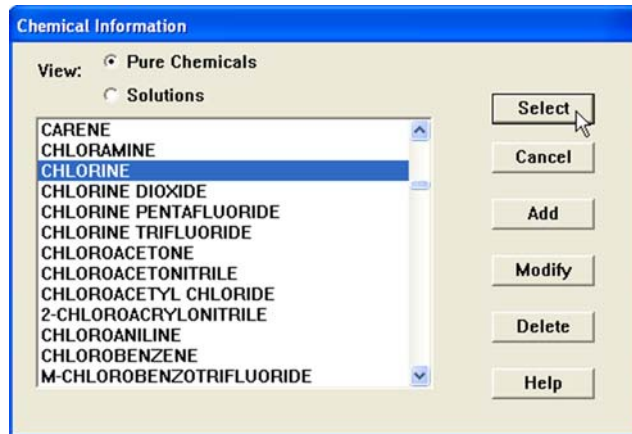


### Chemical

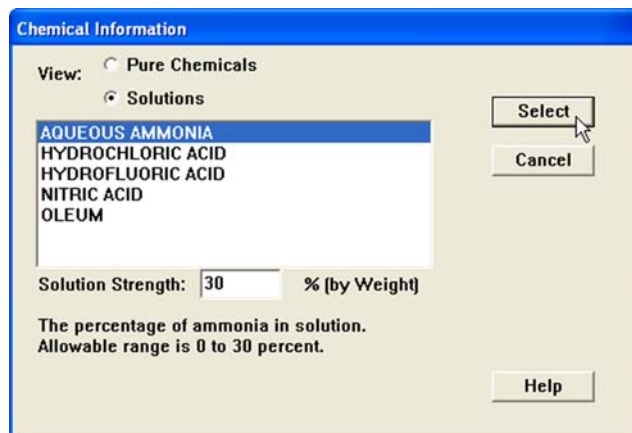
Select **Chemical** from the **SetUp** menu to access a list of the chemicals included in ALOHA's chemical library (ChemLib). Physical property and toxicological data for about 1,000 pure chemicals are included in the library. ALOHA uses the information in the library to predict how a particular chemical may escape from a container and disperse in the atmosphere. The library does not include any chemical mixtures, chemicals with unstable structures, or chemicals of such low volatility and toxicity that they don't represent air dispersion hazards (that is, solids or liquids with very low vapor pressures that present a toxic hazard only when present at high concentrations). The library does contain a small number of solutions. You can add pure chemicals to the library or delete chemicals from it, and you can modify information about the physical properties of any pure chemical.

**Note:** You cannot view or modify properties that were obtained from the proprietary Design Institute for Physical Properties Data (DIPPR®) database.

**Selecting a pure chemical.** To choose a pure chemical, locate its name in the chemical list. Chemical names appear in alphabetical order in the list, with prefixes such as “n-,” “tert-,” or “1, 2-” ignored. To navigate quickly through the list, type the first one or two letters of the name, then scroll up or down until you see the name of the chemical that you wish to select. Double-click on the name (or click once on the name, then click **Select**) to select it. Once you have selected a chemical, you’ll see some of its most important properties listed in the Text Summary window.



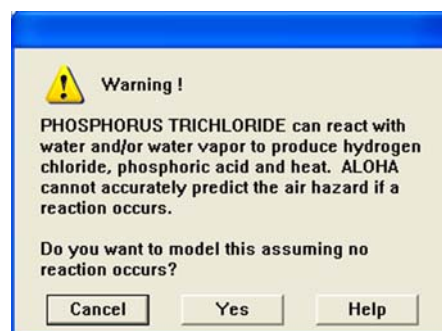
**Selecting a chemical solution.** To choose one of ALOHA’s chemical solutions, click on the **Solutions** option to display the list of solutions. Double-click on the name (or click once on the name, then click **Select**) to select it. Type in its percent by weight in the Solution Strength box (ALOHA shows you the allowable range). Once you have selected a solution, you’ll see some of its most important properties listed in the Text Summary window.



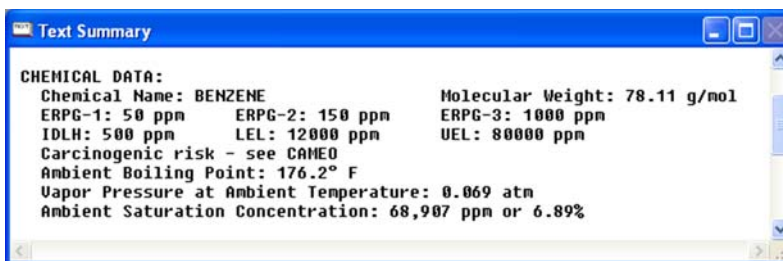
**Reactive chemicals.** ALOHA assumes that the molecules in the released chemical do not react with each other or with the gases that make up the atmosphere, such as oxygen and water vapor. That is, ALOHA assumes that the molecules that disperse in the atmosphere are the same molecules that originally escaped from a container. However, some chemicals react with dry or humid air, water, other chemicals, or even themselves. Because of these chemical reactions, some or all of the molecules that disperse downwind sometimes may be very different from the molecules that originally escaped from containment. They may be heavier or lighter than the original molecules, may have different properties and behave differently in the atmosphere, and may be more or less toxic than the original chemical. In some cases, these differences may be substantial enough to make ALOHA's predictions inaccurate.

ALOHA will allow you to model any reactive chemical as a non-reactive chemical, but it will warn you that it may not be able to produce accurate results. When you select an air- or water-reactive chemical, ALOHA will alert you that the chemical is reactive, and will describe the type of reaction and reaction products to expect.

If you choose to model the chemical, ALOHA will place a similar warning in the Text Summary window as an additional reminder.



**Chemical information in the Text Summary window.** Review the Text Summary for information about the chemical you've selected. For example, values for some properties of benzene appear in the Text Summary below. You can see, for example, that benzene's boiling point is well above most ambient temperatures, so you can expect to encounter it as a liquid.



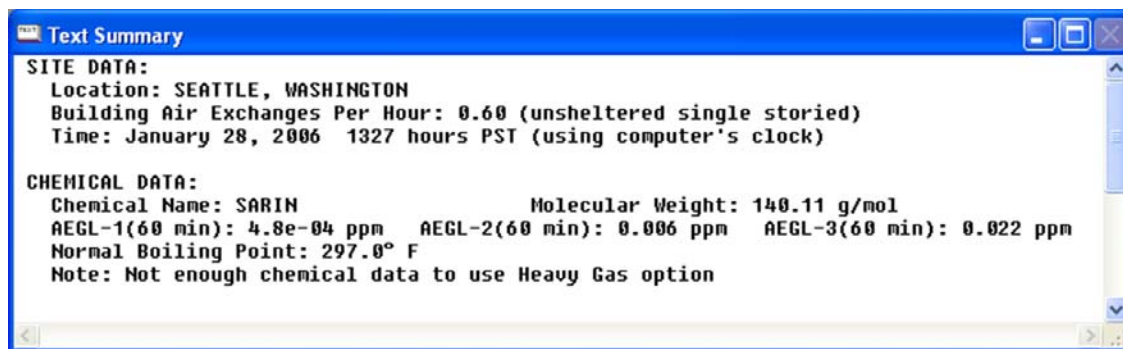
Some items in the chemical information summary need some explanation:

- *Ambient Saturation Concentration.* Within a confined space such as a cargo hold or warehouse, at a given temperature, the ambient saturation concentration is the maximum concentration in the air that the vapor evaporating from a liquid pool may reach. If a chemical has a high ambient saturation concentration, it has a strong ability to displace air, and the concentration of the chemical's vapor in the air above the liquid will be high. If it's low, the vapor concentration will be low. This property changes with temperature—a liquid at a higher temperature will have a higher ambient saturation concentration. The ambient saturation concentration of a gas is 1,000,000 parts per million, or 100 percent. ALOHA displays ambient saturation concentration because it can sometimes be useful to you to compare it with a threshold concentration of concern, such as a Lower Explosive Limit.

- *Level of Concern (LOC)*. An LOC is a threshold value of a hazard (toxicity, flammability, thermal radiation, or overpressure); the LOC is usually the value above which a threat to people or property may exist. A list of standard LOCs will appear on the Text Summary screen, including: AEGLs, ERPGs, TEELs, IDLH, UEL, and LEL. For toxicity, there are often several different standard LOC value to choose from—AEGLs, ERPGs, TEELs, and IDLH all relate to toxic thresholds. ALOHA uses the following hierarchy to choose a default toxic LOC: (1) 60-minute AEGL, (2) ERPG, (3) TEEL, and (4) IDLH. **For AEGLs, ERPGs, and TEELs, the rank number increases with the hazard level, so that AEGL-3 is more hazardous than AEGL-1.** Typically, the “-3” values are used for the red *threat zones* which represent the worst hazard.

ALOHA sometimes places notes in the Text Summary:

- When you select a chemical such as benzene which has been identified as a confirmed, potential, or suspected carcinogen, a notation (**Carcinogenic risk - see CAMEO**) will appear in the Text Summary.
- When you select a chemical for which little information is available, ALOHA displays the following note in the Text Summary: **Not enough chemical data to use Heavy Gas option**. This note alerts you that, although the chemical’s molecular weight is heavier than 29 kilograms per kilomole (the average molecular weight of air) so that it may behave like a heavy gas, ALOHA will have to use Gaussian dispersion calculations to model its behavior in the atmosphere, unless you add additional property information.



**Chemical data.** The chemical library includes information about the physical properties of each ALOHA chemical. It also includes—depending on the chemical—values for AEGLs (60-minute), ERPGs, TEELs, IDLH, UEL, and LEL. You can add your own toxic LOC for any pure chemical to ALOHA’s chemical library. ALOHA will automatically use your LOC as the default for the selected chemical.

The ALOHA library contains information from two sources. When available, physical property values were obtained from a chemical database compiled by the Design Institute for Physical Properties Data (DIPPR), known as the DIPPR database. Other values were obtained from the chemical database included in the Computer-Aided Management of Emergency Operations (CAMEO®) hazardous chemical information system (developed by the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration).

ALOHA uses information from the library to model the physical behavior of a chemical that you have selected. For example, once ALOHA knows the temperature within a tank, it can use library information to estimate the vapor pressure, density, and other properties of the chemical stored in the tank.

You only need the name of a chemical and its molecular weight to run the simplest ALOHA scenario—a toxic gas dispersion using a Direct source and the Gaussian dispersion model. However, ALOHA's more complex calculations require information about other properties of the chemical. Check Table 5-1 for the property information needed for each source and dispersion model option. (You do not need to add a value for liquid density because ALOHA estimates this property from other information that you enter.)

**Table 5-1: Properties needed to use each ALOHA source and dispersion option.**

Property	Direct	Puddle	Tank	Pipeline	Heavy Gas	Gaussian
Chemical Name	+	+	+	+	+	+
Molecular Weight	+	+	+	+	+	+
Normal Boiling Point	<>	+	+	+	+	
Critical Pressure	<>	+	+	+	[]	
Critical Temperature	<>	+	+	+	[]	
Gas Density					+	
Normal Freezing Point		+	+			
Gas Heat Capacity		+	+	+	+	
Liquid Heat Capacity		+	+			
Heat of Combustion	F	F	F	F		
Vapor Pressure					**	
<p>+ Required property value.</p> <p>&lt;&gt; Required if release rate or amount is expressed in volume units (gallons, liters, or cubic meters).</p> <p>[] Required if vapor pressure is not entered.</p> <p>F Required if the chemical is flammable and you want to run scenarios where it may catch on fire.</p> <p>** Required if critical temperature and critical pressure are not entered.</p>						
<p><b>Note: For some fire and explosion scenarios you may also have to enter explosive limits. To calculate the flammable areas of a flash fire, ALOHA must have the LEL (Lower Explosive Level). To model a vapor cloud explosion, ALOHA must have the LEL and the UEL (Upper Explosive Limit).</b></p>						



**Adding a chemical to the library.** Select **Chemical** from the **SetUp** menu, then click **Add** on the dialog box that appears. Type the chemical's name in the Chemical Name box. Next, type its molecular weight (in grams per mole) in the molecular weight box. Then add values for all other properties that you'll need to run ALOHA (check Table 5-1 to see which properties are necessary for ALOHA's various source and dispersion options). To enter additional property values, click on the name of each property in the scrolling list of property names (or click **Next Field** until the property name is highlighted). Type property values in the appropriate boxes, then choose units.

You must add a reference temperature and pressure for all properties that change their values when temperature and/or pressure changes. For example, if you were adding a fictional chemical (such as methyl ethyl death) into the chemical library, you would need to know that it has a gas heat capacity of 1,500 joules per kilogram Kelvin at a temperature of 320 Kelvin and a pressure of 101,325 pascals.

Once you have entered all information about a new chemical, click **OK** to permanently add your new chemical to ALOHA's chemical library. The Chemical Information dialog box appears with the newly updated list of chemicals in ALOHA's chemical library. Click **Select** to select the chemical that you've just added. Click **Cancel** if you decide not to permanently add the chemical to the library.

**Modifying a chemical entry in the library.** To modify information about a chemical, first select **Chemical** from the **SetUp** menu. Select the name of the chemical in the dialog box that appears, then click **Modify**. Click on the name of each property that you are adding or modifying in the scrolling list (or click **Next Field** until you've highlighted the property name). Type property values in the corresponding boxes, or modify existing values, and modify units if necessary.

You'll find that you cannot modify all property values for ALOHA chemicals already included in the library. Values that you cannot modify, and their units, appear dimmed. These are values that ALOHA calculates internally, using either values for the chemical's critical properties (molecular weight, boiling point, critical temperature, and critical pressure) or information from the *DIPPR database*. If you would like to use your own property values for an ALOHA chemical, add the chemical using a slightly different name—such as CHLORINE-2—and type your own values in the new property boxes.

When you're finished making your modifications, click **OK** to add them permanently to ALOHA's library. To avoid making permanent changes to the library, click **Cancel**.

**Deleting a chemical from the library.** To permanently delete a chemical from ALOHA's library, select **Chemical** from the **SetUp** menu. Select the name of the chemical in the dialog box that appears, then click **Delete**. Click **OK** to delete the chemical permanently from ALOHA's library. Click **Cancel** to avoid deleting the chemical.

## Atmospheric

You can enter information about current weather conditions into ALOHA either manually (by typing in values for wind speed, air temperature, and other weather factors) or by connecting your computer to a portable meteorological station, called a *SAM* (Station for Atmospheric Measurement). ALOHA uses the information that you enter to account for the main processes that affect the results of the various scenarios. These include atmospheric heating and mechanical stirring, low-level *inversions*, wind speed and direction, *ground roughness*, and air temperature.

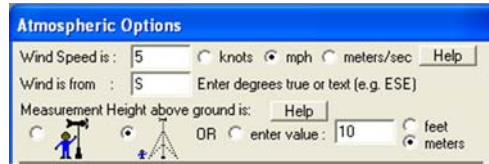
## User Input

In the **SetUp** menu, point to **Atmospheric**, then select **User Input**. The first of two Atmospheric Options dialog boxes appears. In the dialog boxes, manually enter the following information about conditions in the vicinity of an accidental release: wind speed and direction, wind measurement height, *ground roughness*, *cloud cover*, air temperature, *atmospheric stability* class, *inversion* height (if a low-level inversion exists), and *relative humidity*.



ALOHA assumes that weather conditions remain constant throughout the incident area. For this reason, use values that best represent conditions throughout this area. If weather conditions change, update this information and run ALOHA again.

**Wind speed, direction, and measurement height.** ALOHA needs to know the wind speed and direction, as well as the height at which the wind speed and direction are measured. The *wind direction* determines which way a pollutant cloud will drift. The wind speed affects not only how fast the cloud will travel downwind, but also how much it moves about in the crosswind and vertical directions. When the wind is slower, the cloud meanders more.



Use Table 5-2 when you need to estimate the wind speed from environmental clues. For example, when the wind speed is 12 knots, you would expect to see small branches of trees and bushes moving slightly, and dust and loose paper blowing along the ground.

**Table 5-2: Estimating wind speed from environmental clues.**  
(One knot equals 1.15 miles per hour.)

Meters per Second	Knots	International Description	Specifications
<1	<1	Calm	Calm; smoke rises vertically
<1-2	1-3	Light air	Direction of wind shown by smoke drift, but not by wind vanes
2-3	4-6	Light breeze	Wind felt on face; leaves rustle; ordinary vane moved by wind
4-5	7-10	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag
5-8	11-16	Moderate	Raises dust, loose paper; small branches are moved
8-11	17-21	Fresh	Small trees in leaf begin to sway; crested wavelets form on inland water
11-14	22-27	Strong	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty
14-17	28-33	Near gale	Whole trees in motion; inconvenience felt walking against wind
17-21	34-40	Gale	Breaks twigs off trees; generally impedes progress

Enter the direction **from** which the wind is blowing, using either units of degrees true, or one- to three-letter directional terms. For example, you can indicate that the wind is blowing from the north-northeast by entering either NNE or 22.5 degrees.

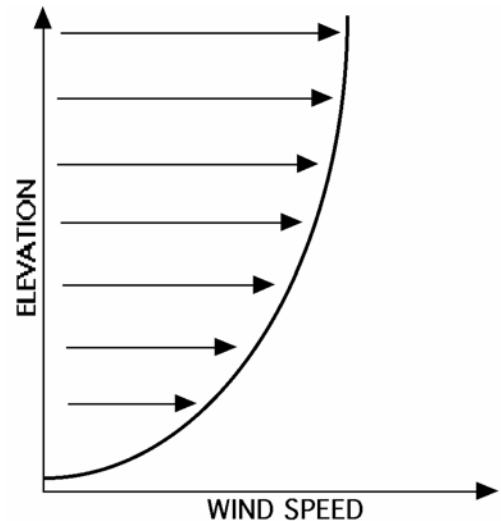
**Table 5-3: Wind directions expressed in letter terms and corresponding degrees.**

Directional Letter(s)	Degrees	Directional Letter(s)	Degrees
N	0 or 360	S	180
NNE	22.5	SSW	202.5
NE	45	SW	225
ENE	67.5	WSW	247.5
E	90	W	270
ESE	112.5	WNW	292.5
SE	135	NW	315
SSE	157.5	NNW	337.5

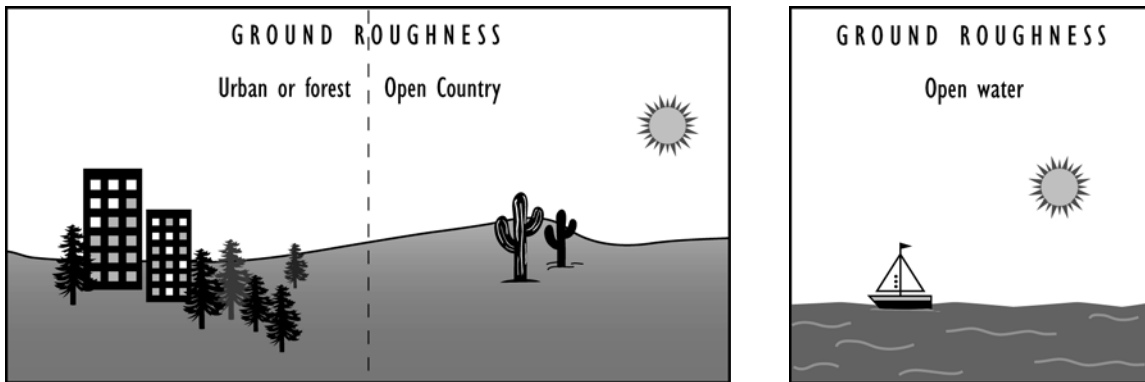
Finally, enter the height at which wind speed and direction have been measured. ALOHA accounts for the way in which wind speed changes with height in a pattern called a wind profile. Close to the ground, friction slows the wind. At higher elevations, the wind speed is faster. High enough up (typically a few hundred yards or meters, or higher), the wind speed reaches a maximum, because it is no longer affected by friction (as shown at the right in a wind profile).

Indicate the wind measurement height in the “Measurement height above ground” section. Choose one of the following three options to indicate the height:

- SAMs typically are mounted on a 3-meter (9.8-foot) stand, so the wind reference height for readings from a SAM is likely to be 3 meters. Select the icon on the left (the one with the close-up view of a person) to indicate a height of 3 meters—this is ALOHA’s default measurement height.
- The National Weather Service usually reports wind speed measured at a height of 10 meters (about 33 feet). Select the icon on the right (the one of the tower) to indicate a height of 10 meters.
- If you know that your wind speed value is being measured at a different height, type that height in the measurement height box, then choose units.

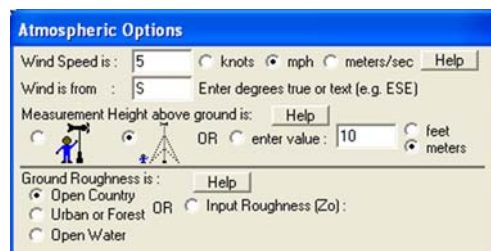


**Ground roughness.** The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix with the air around it and be diluted below your LOC. Friction between the ground and air passing over it is one cause of atmospheric turbulence. Because the air nearest the ground is slowed the most, eddies develop, just as they would in the water next to a riverbank. The rougher the ground surface, the greater the ground roughness, and the greater the turbulence that develops. Ground roughness is determined by number and size of roughness elements present in an area. A roughness element is a surface feature that disturbs the flow of air, but is small relative to the size of a pollutant cloud.



To indicate the ground roughness downwind of a release, either (a) choose one of three roughness classes—**Open Country** (low roughness, low turbulence), **Urban or Forest** (high roughness, high turbulence), or **Open Water** (very low roughness, very low turbulence)—or (b) enter your own value for roughness length,  $Z_o$ , a term used by meteorologists to describe ground roughness.

- Click **Open Country** if there are only small or few roughness elements in the area. Examples include farmland, grassland, and large parking lots.
- Click **Urban or Forest** if the area has many friction-generating roughness elements, such as trees or small buildings. Examples include residential housing developments, industrial areas, and forests.
- Click **Open Water** if a pollutant cloud is travelling over a large body of water (relative to size of the cloud). Examples include oceans and large lakes. Except when the wind speed is very high, Open Water is the lowest ground roughness category in ALOHA.



A chemical cloud generally travels farther across open country and open water than over an urban area or a forest. This is because it encounters fewer, smaller roughness elements to create turbulence.

Choose the dominant category of ground roughness in the area where the pollutant cloud may travel. For example, if 70% of the area is urban or forest and 30% is open country, click Urban or Forest. If you can't easily determine the dominant category, run ALOHA once with each category selected to get an idea of the possible range in threat zone size.

If something, such as a tall building, is very large relative to the pollutant cloud, it is likely to be an *obstacle* that diverts a pollutant cloud rather than a roughness element that generates turbulence. For example, in a downtown area on a Sunday morning with no cars on the streets, the best ground roughness category for a small release may be Open Country. In this case, the buildings are obstacles and the street is the roughness the pollutant cloud will experience.

#### How does ALOHA interpret your $Z_o$ value?

It depends on whether it uses Gaussian or heavy gas dispersion calculations. When ALOHA makes its heavy gas calculations, it uses the  $Z_o$  value that you entered, unless it is greater than 10 cm. In such cases, ALOHA assumes  $Z_o$  to be 10 cm. When ALOHA makes its Gaussian calculations, if you enter a  $Z_o$  value of 20 cm or more, ALOHA uses the Urban or Forest roughness parameters. If you enter a  $Z_o$  value of less than 20 cm, ALOHA uses the Open Country roughness parameters.

If you prefer to type in a value for roughness length ( $Z_o$ ), you can refer to Table 5-4. Note that roughness length is not a simple function of the height of the roughness elements in an area.

**Table 5-4: Surface Roughness ( $Z_o$ ) Equivalences from Brutsaert 1982.**

Surface description	$Z_o$ (cm)
Mud flats, ice	0.001
Smooth tarmac (airport runway)	0.002
Large water surfaces (average)	0.01- 0.06
Grass (lawn to 1 cm high)	0.1
Grass (airport)	0.45
Grass (prairie)	0.64
Grass (artificial, 7.5 cm high)	1
Grass (thick to 10 cm high)	2.3
Grass (thin to 50 cm)	5
Wheat stubble plain (18 cm)	2.44
Grass (with bushes, some trees)	4
1-2 m high vegetation	20
Trees (10-15 m high)	40-70
Savannah scrub (trees, grass, sand)	40
Large city (Tokyo)	165

**Cloud cover.** ALOHA needs a value for cloud cover, the proportion of the sky that is covered by clouds, in order to estimate the amount of incoming solar radiation at the time of a chemical release. Solar radiation is an important influence on puddle evaporation rate because heat from the sun can warm a puddle and speed up evaporation. In the U.S., cloud cover is usually measured in tenths: when the sky is completely covered by clouds, cloud cover is 10 tenths; when half the sky is covered by clouds, it is 5 tenths; when the sky is completely clear, it is 0 tenths. These values are represented by the complete cover, partly cloudy, and clear icons, respectively.

The screenshot shows the 'Atmospheric Options' dialog box with the following settings:

- Wind Speed is: 5 (mph selected)
- Wind is from: S
- Measurement Height above ground is: 10 (feet selected)
- Ground Roughness is: Open Country
- Select Cloud Cover: partly cloudy icon selected, with an input field showing 3.

To select cloud cover, either:

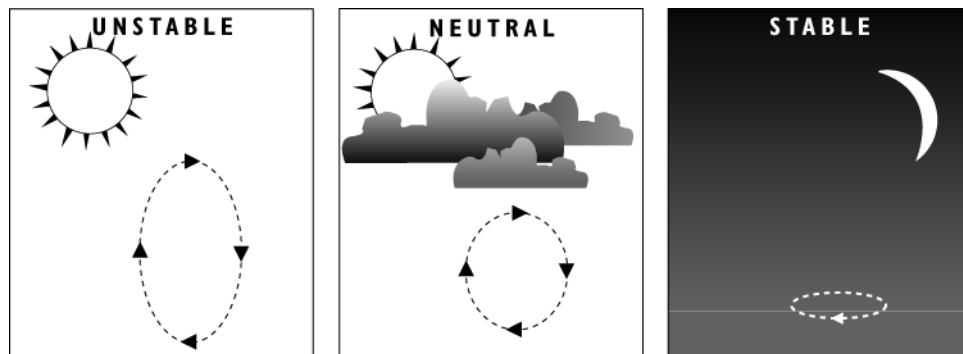
- Click the button corresponding to either 0, 3, 5, 7, or 10 tenths; or
- Type a whole number between 0 and 10 in the box for cloud cover value in tenths (for example, type “6” if cloud cover is 6 tenths).

**Air temperature.** ALOHA requires a value for the air temperature in the vicinity of a chemical release. You can enter a value in either degrees Fahrenheit (°F) or degrees Celsius (°C). Air temperature influences ALOHA’s estimate of the evaporation rate from a puddle surface (the higher the air temperature, the more the puddle is warmed by the air above it, the higher the liquid’s vapor pressure is, and the faster the substance evaporates). Because several physical processes involved in a chemical release are affected by temperature, use as accurate a value as possible.

The screenshot shows the 'Atmospheric Options 2' dialog box with the following settings:

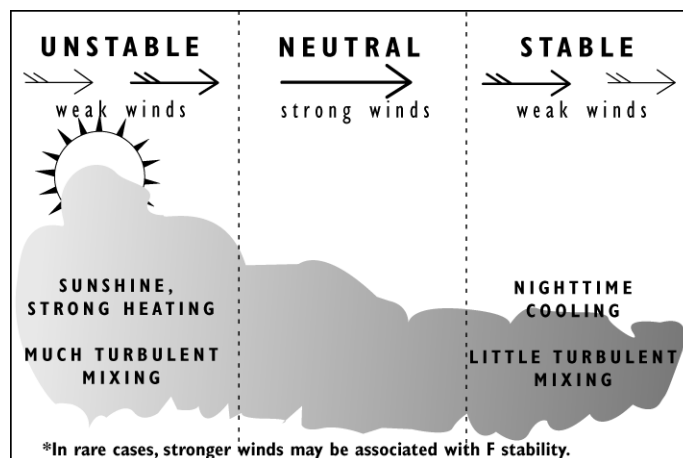
- Air Temperature is: 72 (Degrees F selected)
- Stability Class is: C
- Inversion Height Options are: No Inversion

**Stability class.** The atmosphere may be more or less turbulent at any given time, depending on the amount of incoming solar radiation as well as other factors. Meteorologists have defined six atmospheric stability classes, each representing a different degree of turbulence in the atmosphere. When moderate to strong incoming solar radiation heats air near the ground, causing it to rise and generating large eddies, the atmosphere is considered *unstable* (relatively turbulent). Unstable conditions are associated with atmospheric stability classes A and B. When solar radiation is relatively weak or absent, air near the surface has a reduced tendency to rise, and less turbulence develops. In this case, the atmosphere is considered *stable* (less turbulent), the wind is weak, and the stability class would be E or F. Stability classes D and C represent conditions of more neutral stability (moderate turbulence). Neutral conditions are associated with relatively strong wind speeds and moderate solar radiation.



**Figure 5-1.** Effects of solar radiation on atmospheric stability.

Stability class has a big effect on ALOHA's prediction of the threat zone size for dispersion scenarios. Under unstable conditions, a dispersing gas mixes rapidly with the air around it. ALOHA expects that the cloud will not extend as far downwind as it would under more stable conditions, because the pollutant is soon diluted to below your LOC, and ALOHA will display a shorter threat zone than it would for more stable conditions.



**Figure 5-2.** Stability class and mixing of a pollutant cloud.



ALOHA uses Table 5-5 (based on Turner 1994) to automatically choose the stability class that best represents the weather conditions that you enter. If more than one stability class fits the conditions that you indicate, ALOHA selects the most stable of these classes. For example, if both A and B fit the conditions, ALOHA selects B. However, you can click A if you believe this class to be more appropriate. Buttons for stability classes inappropriate for those conditions are unavailable for selection.

**Table 5-5: Stability class and wind speed.**

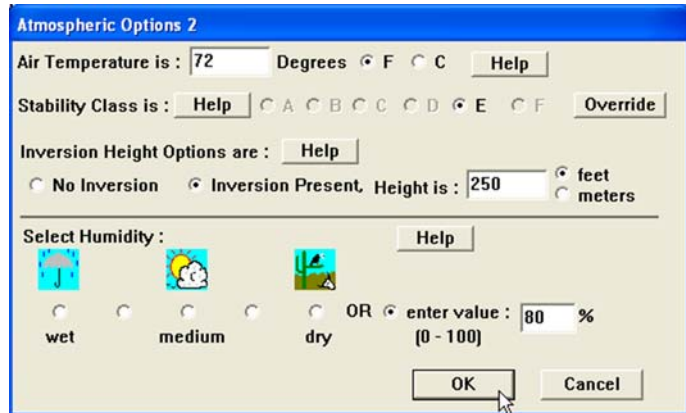
Wind Speed*			Day: Incoming Solar Radiation			Night: Cloud Cover	
Meters per second	Knots	Miles per hour	Strong**	Moderate	Slight***	>50%	<50%
<2	<3.9	<4.5	A	A-B	B	E	F
2-3	3.9-5.8	4.5-6.7	A-B	B	C	E	F
3-5	5.8-9.7	6.7-11.2	B	B-C	C	D	E
5-6	9.7-11.7	11.2-13.4	C	C-D	D	D	D
>6	>11.7	>13.4	C	D	D	D	D
Note: Stability is D for completely overcast conditions during day or night.							
Note: This table is for releases over land. If the release occurs over water, the stability class will be either D or E.							
* Wind reference height is 10 meters.							
** “Strong” solar radiation corresponds to clear skies with the sun high in the sky (solar angle greater than 60 degrees).							
+ “Slight” solar radiation corresponds to clear skies with the sun low in the sky (solar angle between 15 and 35 degrees).							

You can click **Override** to change ALOHA’s stability class choice and choose any of the six stability classes. You should do this, however, only if you are sure that a special circumstance causes the best choice for stability class to be different from the choice made by ALOHA. For example, the atmosphere above a snow-covered landscape is typically more stable than would be expected for a given combination of wind speed, cloud cover, and time of day. If you are modeling a release over snow-covered ground, then you might want to choose a more stable class than ALOHA chooses for you. Additionally, some organizations may require users to model all scenarios using a single scenario class—in which case, they usually pick stability class F to model the worst-case scenarios.

**Inversion height.** An inversion is an atmospheric condition in which an unstable layer of air near the ground lies beneath a very stable layer of air above. The height of the abrupt change of atmospheric stability is called the inversion height. An inversion can trap pollutant gases below the inversion height, causing ground-level concentrations of a pollutant to reach higher levels than would otherwise be expected.

The type of inversion of concern for dispersion modeling is a low-level inversion that could trap a pollutant cloud near the ground. Sea smoke and low ground fog are good indicators of the presence of this type of inversion. A low-level inversion is different from the inversion that causes smog. That type of inversion is typically thousands of feet above the ground—much too high to affect a dispersing gas cloud.

ALOHA's Gaussian dispersion model accounts for inversions, but the heavy gas model does not, even when you've indicated that an inversion exists. A low-level inversion may significantly increase ground-level concentrations of a neutrally buoyant gas. Molecules of such gases disperse upwards and outwards as they are transported downwind, and are reflected from an inversion layer back towards the ground. A heavy gas cloud, in contrast, remains close to the ground as it disperses, and is not normally affected even by low-level inversions.



If a low-level inversion is present, type in the height of the inversion layer and select units. If there is no low-level inversion, be sure that **No Inversion** is selected.

**Humidity.** Relative humidity is the ratio of the amount of water vapor that the air contains to the maximum amount of water vapor that the air could hold at the ambient temperature and pressure. Relative humidity is expressed as a percentage. When relative humidity is 50 percent, the air contains one-half as much water vapor as it could potentially hold. The warmer the air, the greater its capacity to contain water vapor. Cold air may contain little water vapor but have a high relative humidity because the amount of water vapor in the air is near the air's relatively low maximum capacity.

ALOHA uses the relative humidity value to:

- Estimate the atmospheric transmissivity value;
- Estimate the rate of evaporation from a puddle; and
- Make heavy gas dispersion computations.

Atmospheric transmissivity is a measure of how much thermal radiation from a fire is absorbed and scattered by the water vapor and other atmospheric components. ALOHA estimates the transmissivity from relative humidity and uses the transmissivity when estimating thermal radiation threat zones. Lower relative humidity values will result in longer threat zone estimates. Response techniques, like a water-fog, artificially increase water vapor and decrease the transmissivity in the incident area to try to reduce the thermal radiation hazard.

Enter a relative humidity value in either of two ways: either select the option that best represents your relative humidity value, or type the relative humidity (as a percentage) in the humidity value box.

## SAM Station

Although you can enter all weather information into ALOHA manually, ALOHA can also accept data from an external portable meteorological monitoring station, called a *Station for Atmospheric Measurement (SAM)*. SAM data can be transmitted to ALOHA by either radio frequency or a cable. ALOHA can use SAM measurements of wind speed and direction, standard deviation of the wind direction, and air temperature. (ALOHA cannot accept relative humidity readings made by a SAM; you'll need to enter these measurements into ALOHA manually.)

**Choosing a SAM.** A few companies manufacture SAMs for use with ALOHA. Before purchasing a SAM to use with ALOHA, check with its manufacturer to be sure that it is designed to work with ALOHA, and to learn how to connect the station to your computer so that it can transmit data to ALOHA. Before using a station not specifically designed for ALOHA, be sure that it transmits data in a format that ALOHA can accept (this format is described below).

**Transmitting SAM data to ALOHA.** For use with ALOHA, a SAM must meet several design criteria. The SAM should sample wind speed and direction at a rate of at least one sample every 2 seconds. It must transmit wind speed and direction and air temperature readings every 30 seconds. (Because air temperature does not change quickly over time, it may be sampled less frequently than wind speed and direction.) Data transmitted from your SAM to ALOHA must be in the following free-field, comma-delimited format (ALOHA displays unprocessed SAM data in the same format):

```
<cr> <lf> ID,VS,WD,SD,TA,SP,DI,TI,B,CHK,
```

**Table 5-6: Translation key for SAM data codes.**

Code	Required Information
<cr>	Carriage return (ASCII character code 13)
<lf>	Line feed (ASCII character code 10)
ID	Station identification number
VS	Vector mean wind speed, averaged over 5 minutes in meters per second
WD	Mean wind direction, averaged over 5 minutes, in degrees true
SD	Standard deviation of the wind direction ("sigma theta") in degrees
TA	Mean air temperature, averaged over 5 minutes, in degrees Celsius
SP	Instantaneous wind speed in meters per second
DI	Instantaneous wind direction in degrees true
TI	Instantaneous air temperature in degrees Celsius
B	Instantaneous SAM battery voltage in volts
CHK	Checksum, computed by summing the ASCII values of all preceding characters in the data line, including the carriage return and line feed characters and the preceding comma

During the first five minutes of data collection, the SAM should transmit “-1” as its value for SD (*sigma theta*). Although a station ID number must be included in each data transmission, ALOHA does not use this value. Wind direction should be the direction from which the wind is blowing.

If the SAM checks automatically for invalid data and finds an erroneous value, it should transmit a data line that includes, in place of that value, either no value (the data line would then contain two successive commas with no value between them: “,,”) or a word such as “error” as its value for an invalid datum (the data line would then contain “,error,”). Because ALOHA does not check SAM data transmissions for unacceptable values, the SAM should not transmit a numeric value such as “999” in place of an erroneous value.

**Using a SAM during an incident.** When you use a SAM with ALOHA during incident response, place your SAM so that its readings will be as representative as possible of the whole area through which the pollutant cloud may travel. Be sure to place it at a location such as an open field, parking lot, or clearing where the wind is not affected by obstacles, such as trees, buildings, or hills. Avoid placing a SAM in the lee of buildings, vehicles, or other obstacles to wind flow, where wind speed and direction may be very different from the rest of the area. Place the SAM upwind of the source of a pollutant gas release so that you will not need to decontaminate it after use.

**Choosing the correct port for receiving SAM data.** SAM data is transmitted to ALOHA through your computer’s *serial port*. On a Windows computer, this is the COM1, COM2, COM3, or COM4 port. On a Macintosh computer, this is the modem port.

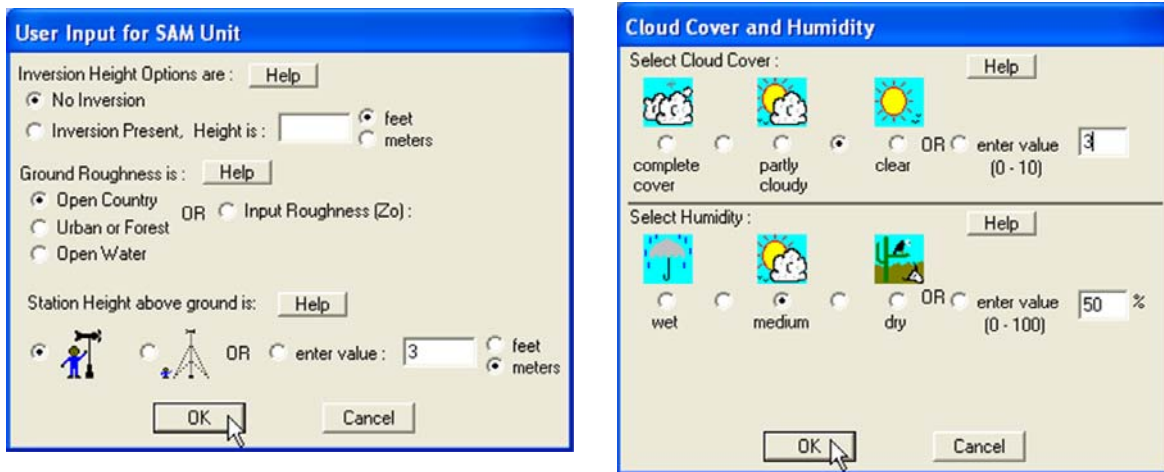
**Choosing a radio frequency.** If you are using ALOHA within the U.S., you’ll find that the rules for assigning and using radio frequencies are specific to your locality; no national guidelines exist. Check with the manufacturer of your SAM, or with the government authority in your area that assigns radio frequencies, if you want to be assigned a frequency that you can use to transmit SAM information to ALOHA. This authority could be a local, state, or federal agency, depending on your location.

**Setting up ALOHA when you’re using a SAM.** Check to be sure that your SAM is properly connected, configured, and turned on (you’ll need to check with the manufacturer if you have questions on how to do this). Next, in the **SetUp** menu, point to **Atmospheric**, then select **SAM Station**. If you are using a Windows computer, you will be asked to indicate the port to which the SAM station is connected.



You'll need to enter some information about environmental conditions:

- If a low-level *inversion* is present, type in the height of the inversion layer and select appropriate units. If there is no inversion, be sure that No Inversion is selected.
- Indicate the *ground roughness* in the area downwind of the release point.
- Specify the station height (the height of the instruments above the ground).
- Indicate the amount of *cloud cover*, in tenths.
- Enter a value for *relative humidity* (as a percentage). Even if your SAM can measure relative humidity, you'll need to enter this value manually into ALOHA.



ALOHA will not allow you to choose items from the Source menu until the SAM has been collecting data for at least 5 minutes.

**SAM Options.** After you click **OK** on the Cloud Cover and Humidity dialog box, you'll see a new menu, **SAM Options**, to the right of ALOHA's **Sharing** menu. You need not choose any items in this menu to use a SAM with ALOHA. Instead, use them when you want to view or archive weather information collected by the SAM.



**Archive Data.** Choose **Archive Data** from the **SAM Options** menu to create a tab-delimited text file containing data from the SAM along with dates and times of transmissions. You will be asked to name the archive file. Type in a file name, then click **Save**. ALOHA then creates this file for you as it receives SAM data, adding data each time it receives new information from the SAM.

Data are arranged in columns and rows within the archive file. The first three lines in the file contain an explanation of units, and the date and time when the data were collected. The fourth line contains the column headings, as follows:

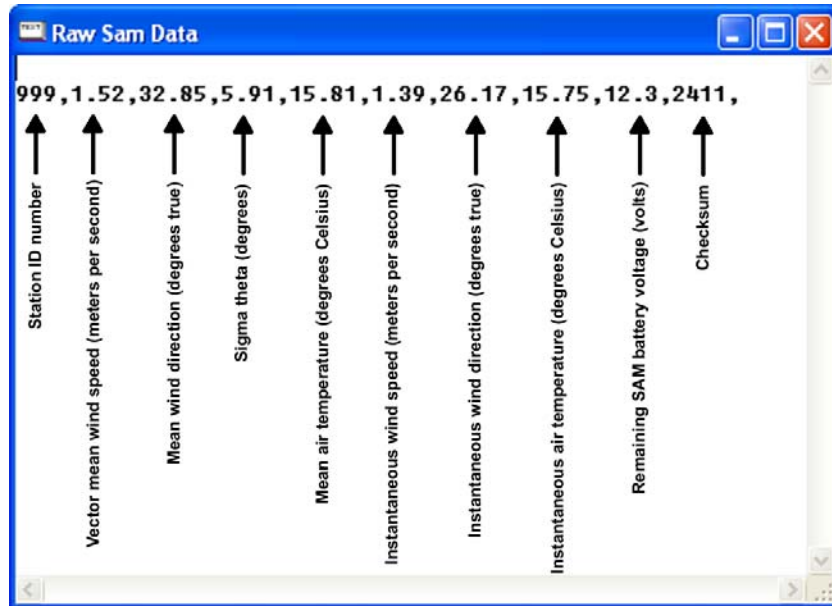
Hr Min Sec ID mW/S mDir SigTh mTemp iW/S iDir iTemp BatVol,

**Table 5-7: Translation key for SAM column headings.**

Column Heading	Required Information
Hr	Hours
Min	Minutes
Sec	Seconds
ID	Station identification number
mW/S	Vector mean wind speed in meters per second
mDir	Mean direction in degrees true
SigTh	Sigma theta (standard deviation of the wind direction) in degrees
mTemp	Mean air temperature in degrees Celsius
iW/S	Instantaneous wind speed in meters per second
iDir	Instantaneous direction in degrees true
iTemp	Instantaneous temperature in degrees Celsius
BatVol	Instantaneous SAM battery voltage in volts

ALOHA does not place a limit on the amount of data you may archive. To stop data archiving, choose **End Archive Data** from the **SAM Options** menu. You can then open and view the file in any word-processing program. To view the most recently transmitted SAM data without interrupting data archiving, select either **Raw Data** or **Processed Data** from the **SAM Options** menu.

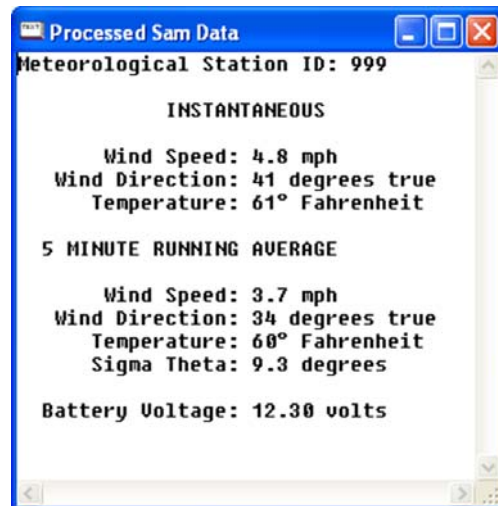
**Raw Data.** Choose **Raw Data** from the **SAM Options** menu to examine the most recently transmitted, unprocessed SAM data. ALOHA displays unprocessed SAM data in the same format in which it is transmitted from the SAM.



**Processed Data.** Choose **Processed Data** from the **SAM Options** menu to view processed weather data, including the most recently transmitted instantaneous readings as well as 5-minute running averaged values, in a new Processed SAM Data window. If ALOHA cannot interpret and process the data that it receives from your SAM, it will display an error message in this window.

Several items in the Processed SAM Window need explanation:

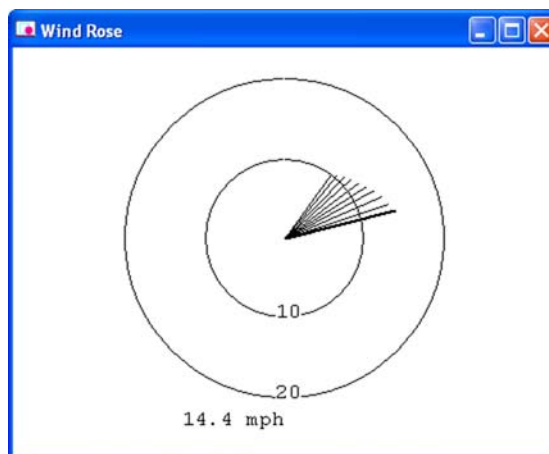
- The **Meteorological Station ID** is the identification code of the SAM that is sending data to your computer (this ID is assigned by the manufacturer).
- **Wind Direction** (in the case of both instantaneous and average values) is the direction from which the wind is blowing.
- The standard deviation of the wind direction is called **Sigma Theta**. This value reflects the amount of fluctuation in the *wind direction* during the last 5 minutes. The more the wind switches direction, the larger is the value of sigma theta. ALOHA uses sigma theta, along with wind speed, cloud cover, and time and date, to choose the stability class for your scenario. The SAM transmits a value of -1.00 for sigma theta until it has been transmitting for 5 minutes.
- **Battery Voltage** is the remaining voltage of the battery on your SAM.



**Wind Rose.** Choose **Wind Rose** from the **SAM Options** menu to view a diagram showing the 10 most recent average wind speed and direction values received from the SAM station. Each line on the diagram represents a 5-minute running average speed and direction. Each line is drawn from the center out towards the direction to which the wind is blowing. Line length indicates wind speed.

The two concentric circles on the diagram represent wind speeds of 10 and 20 miles per hour (mph), if you have indicated a preference for English units, or 5 and 10 meters per second (m/s), if you indicated a preference for metric units (indicate your units preference by choosing **Display Options** from the **Display** menu). The length of each line on the diagram indicates wind speed. For example, a line drawn from the center of the diagram out to the 10 miles per hour circle represents an average wind speed of 10 miles per hour.

The most recent average wind value is represented on the diagram by a darker line. The most recent 5-minute average wind speed is displayed below the diagram.



**Monitoring a long-term release.** You may sometimes use a SAM with ALOHA to monitor weather conditions during a long-term release (such as a slowly evaporating pool of toxic liquid) or a potential spill. When you do so, bear in mind that although your SAM is providing current weather information, other ALOHA inputs may become out-of-date during the course of the response as conditions change. At least once each hour, assess whether you need to adjust important model inputs that could affect ALOHA's estimates of source strength or cloud dispersion. For example, you may respond to a release of a liquid from a storage tank, originally running the release in ALOHA as a Tank source. After an hour or so, the tank may stop leaking, but an evaporating puddle may have formed. In such a case, rerun the scenario in ALOHA as a Puddle source. Later, if the puddle becomes smaller in size as it evaporates or because it is being cleaned up or diked, enter new values for its area and its volume, mass, or depth, then rerun your Puddle scenario.

Whenever you use a SAM with ALOHA, make sure that your computer's internal clock is set to the time and date of the release that you are modeling. ALOHA uses time and date, along with wind speed and cloud cover, to choose stability class.



## Source

In an ALOHA scenario, the *source* is the vessel or pool from which a hazardous chemical is released. The *source strength* is the rate at which the chemical enters the atmosphere or the burn rate, depending on the scenario. A chemical may escape very quickly (so that source strength is high), as when a pressurized container is ruptured, or more slowly over a longer period of time (so that source strength is low), as when a puddle evaporates. ALOHA can model four types of sources.

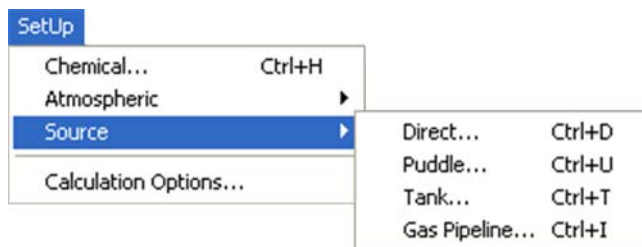
- **Direct:** chemical release directly into the atmosphere (bypassing ALOHA's source calculations).
- **Puddle:** chemical has formed a liquid pool.
- **Tank:** chemical is escaping from a storage tank.
- **Gas Pipeline:** chemical is escaping from a ruptured gas pipeline.

For each source, ALOHA will allow you to choose the scenario(s) you wish to model. The number of available scenarios depends on the source and the chemical released. Table 5-8 lists the scenarios that ALOHA can model for each source.

**Table 5-8: ALOHA sources and scenarios.**

Source	Toxic Scenarios	Fire Scenarios	Explosion Scenarios
<b>Direct</b>			
Direct Release	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
<b>Puddle</b>			
Evaporating	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Pool Fire)		Pool Fire	
<b>Tank</b>			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning		Jet Fire or Pool Fire	
BLEVE		BLEVE (Fireball and Pool Fire)	
<b>Gas Pipeline</b>			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Jet Fire)		Jet Fire	

When you choose one of the four source options from the SetUp menu, you will need to enter information about the release on a series of dialog boxes. Once you click OK on the last dialog box, ALOHA will make its source strength calculations, and you'll be able to review the results of the source calculations—predicted release duration, release rates, total amount released, and other information—in a text summary and on a source strength graph.



**Note:** ALOHA does not display a source strength graph for BLEVE scenarios.

**ALOHA's duration limits.** ALOHA places minimum and maximum limits on the duration of any release. ALOHA expects a release into the atmosphere to continue for at least 1 minute. If ALOHA calculates a source strength (evaporation rate or burn rate) for your current scenario, it estimates it for no more than 1 hour after a release begins. If ALOHA predicts that a release would last longer than 1 hour, you will see a message on the Text Summary window: **Release Duration: ALOHA limited the duration to 1 hour.**

One important reason for the 1-hour duration limit is that the wind changes speed and switches direction frequently. Researchers have found that atmospheric conditions change enough to affect ALOHA's predictions on a time scale of about 1 hour. Bear in mind that ALOHA assumes that weather conditions remain constant for the duration of any release. Another reason is that the calculation methods ALOHA uses are based on the results of experiments. In these experiments, gases were released into the atmosphere for time periods from 10 minutes to 1 hour; the researchers then observed how the dispersing gases behaved.

This 1-hour limit represents the maximum possible release duration. If you are responding to an incident, check whether release conditions change substantially before an hour has passed. For example, if an evaporating puddle has substantially changed in area, or the wind speed or direction has changed, enter new atmospheric and source information into ALOHA and obtain an updated threat zone plot.

#### Release duration for vapor cloud explosions

For vapor cloud explosions, the release can be modeled for less than 1 minute. However, if your chosen release duration—that is, the time until the cloud ignites—is less than one minute, you will not get the maximum possible explosion. Additionally, if you are modelling an instantaneous release from a Direct source, not all of the chemical will be released for times less than one minute because ALOHA models the release as a constant release with a one minute duration.

**ALOHA reports release rate.** When you use ALOHA's Puddle, Tank, or Gas Pipeline source options, ALOHA reports the release rate in the Text Summary as the **Maximum Average Sustained Release Rate** or as the **Maximum Burn Rate**. ALOHA computes release rate from a puddle, tank, or gas pipeline as a series of hundreds of brief timesteps. Each timestep represents a rate of release that is maintained for a particular amount of time (timesteps are short if release rate is changing rapidly, and longer if release rate is nearly constant).

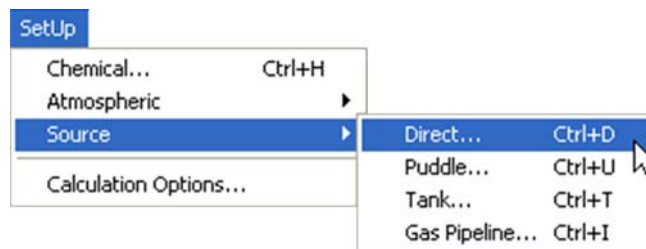
For releases into the atmosphere, ALOHA averages this series of many release rates into between one and five release rates that are each for a time period of at least 1 minute. For burn rates, ALOHA averages over timesteps lasting 20 seconds. (Choose **Source Strength** from the **Display** menu to see a graph of these averaged rate(s) for a particular scenario.) To save calculation time, ALOHA uses these averaged release rate(s) to make its threat zone estimates. The *Maximum Average Sustained Release Rate* (or the *Maximum Burn Rate*, if applicable) is the highest of these averaged release rates. It is represented by the tallest timestep on the Source Strength graph.

When a gas or liquid escapes from a pressurized container, the release rate may drop very quickly (sometimes within seconds) as the pressure within the container drops. In such cases, the initial release rate may be much higher than the maximum average release rate.

**When you're using a SAM.** ALOHA recomputes its threat zone and threat at a point estimates each time it receives new weather data from a SAM. However, it does not recompute source strength when it receives new data. During prolonged incidents, because time of day and weather conditions may have important effects on source strength (especially from an evaporating puddle), be sure to periodically update ALOHA's source strength calculations.

## Direct source

In the **SetUp** menu, point to **Source**, then select **Direct**. Choose the Direct source option if you know the amount of pollutant gas released directly (or evaporated), or if you have too little information about a release to use another source option but feel that you can make a "ballpark estimate" of the total amount of chemical released into the atmosphere. **Note: In ALOHA, "direct" refers to the fact that the scenario information is directly entered by the user, bypassing ALOHA's source calculations.** Whenever you must estimate a value, try entering the largest likely value as well the smallest likely value into ALOHA, then check to see how the size of the threat zone changes when your value changes. If you have enough information about the release, you may wish to choose the Puddle, Tank, or Gas Pipeline source option instead so that ALOHA will make the estimates for you.



To model a direct release of gas into the atmosphere, you will need to estimate the amount of pollutant directly entering the atmosphere as a gas. This could be the amount of pollutant vapor evaporating from a puddle or the amount of gas escaping from a gas pipeline or tank rupture. It would not be the amount of liquid spilling from a tank and forming a puddle, because the liquid is not directly entering the atmosphere. In this case, you need to estimate the rate at which the gas enters the atmosphere (i.e., evaporation rate) rather than the spill rate.

#### Accurately estimating the rate of release

When modeling a Direct source, you can only enter a constant rate for your chosen duration. However, in most releases the rate will change over time. For example, if a chemical escapes from a pressurized tank or gas pipeline, its release rate may decline rapidly as storage pressure drops. If possible, you should choose either the Tank or Gas Pipeline source option. Both account for rate changes over time and will result in more accurate threat zone estimates.

Once you have entered all of the required information, you can set your LOCs and view the threat zones for the vapor cloud. For flammable chemicals you can view the (1) toxic area, (2) flammable area, and (3) blast area (if a vapor cloud explosion occurs). For nonflammable chemicals you can view the toxic threat zones.

**Direct release of gas into the atmosphere.** Begin by selecting the source strength units. You can use units of either weight or volume. (If you use volume units, you must complete a second dialog box where you will specify whether the chemical is a gas or liquid and enter its storage temperature. ALOHA then converts volume to mass to make its source strength computations.) Next, indicate whether the release is **instantaneous** (lasting one minute) or **continuous** (lasting more than one minute). If a release is continuous, type its duration in minutes. (ALOHA has a maximum duration of 60 minutes.)

**Direct Source**

Select source strength units of mass or volume: Help

grams     kilograms     pounds     tons(2,000 lbs)

cubic meters     liters     cubic feet     gallons

---

Select an instantaneous or continuous source: Help

Instantaneous source     Continuous source

---

Enter the amount of pollutant ENTERING THE ATMOSPHERE: Help

pounds/sec    for  minutes

pounds/min    (1-60)

pounds/hr

---

Enter source height (0 if ground source):   feet    Help

meters

OK    Cancel

Type either the amount of pollutant entering the atmosphere (for an instantaneous release) or the rate of entry (for a continuous release). For a continuous source, this value must be expressed as a rate, such as pounds per minute. This is the rate at which a chemical is being released into the atmosphere (i.e., the rate at which a gas is escaping from a tank or the evaporation rate of a puddle). If you must estimate or guess the amount or rate, try entering the largest likely amount (or rate) as well the smallest likely amount (or rate) into ALOHA, then check to see how the size of the threat zone changes when your amount estimate changes.

**Source height.** The *source height* is the height of the location of a chemical release above the ground. Source height is zero if the chemical is released at ground level. Enter a source height greater than zero to model a release from an elevated source only if ALOHA is making Gaussian dispersion calculations. ALOHA does not account for any substantial upward or downward movement of a gas cloud in the atmosphere. Enter a non-zero source height only when the released chemical disperses passively away from the release point, without rising substantially upwards (as a gas emitted from a heated or burning source may do) or slumping downward towards the ground (as a heavy gas may do).

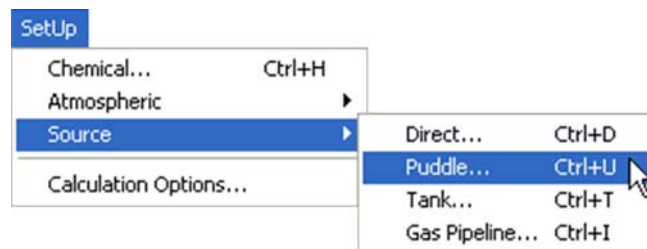
If you enter a source height greater than zero, but your selected chemical is a heavy gas, ALOHA will alert you that it must use a source height of zero to model the release. Although the source height that you entered appears in the Text Summary, ALOHA assumes the height to be zero when making its dispersion computations.

If you are not sure of the source height, bear in mind that a ground-level release is a more conservative choice than an elevated release; ALOHA will predict a longer threat zone for a ground-level release.

## Puddle Source

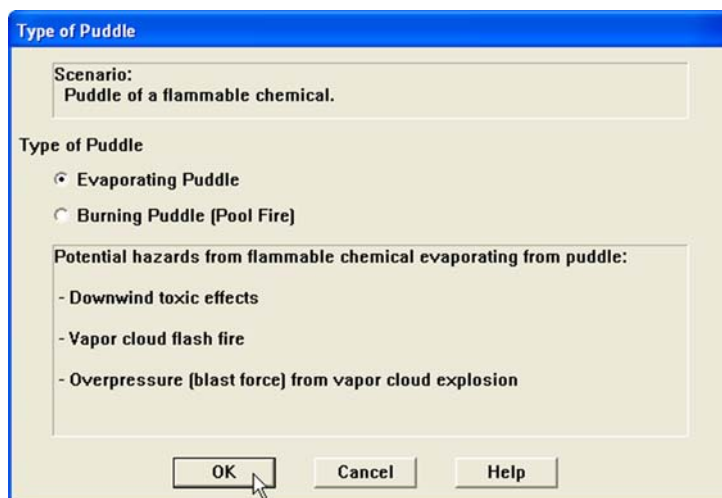
In the **SetUp** menu, point to **Source**, then select **Puddle**. Choose the Puddle source option to model a liquid that has already spilled and formed a puddle on the ground (i.e., it is not changing in area). ALOHA can model the puddle either as an evaporating puddle or, if the chemical is flammable, as a pool fire.

**Note: If liquid is continuing to leak from a tank and spill into a puddle (so that the puddle's area and volume are increasing) choose the Tank source option instead.**



**Type of Puddle.** When you use the Puddle source with a **flammable chemical**, ALOHA will ask you to specify whether you want to model an evaporating puddle or burning puddle (pool fire) before you can enter any details about the puddle.

- **Evaporating Puddle:** As a flammable puddle evaporates, it forms a vapor cloud above the puddle. ALOHA can predict three possible hazardous outcomes: the toxic area of the vapor cloud, the flammable area of the vapor cloud (where igniting the cloud would cause a flash fire), and the overpressure (blast force) from a vapor cloud explosion.
- **Burning Puddle (Pool Fire):** When a flammable puddle catches on fire, it is called a pool fire. Potential hazards associated with a pool fire include thermal radiation, smoke, and toxic byproducts from the fire. ALOHA can help you model the thermal radiation hazard.



When you use the Puddle source with a **nonflammable chemical**, ALOHA will automatically select the evaporating puddle option and the toxic gas output (the only options for a nonflammable chemical).

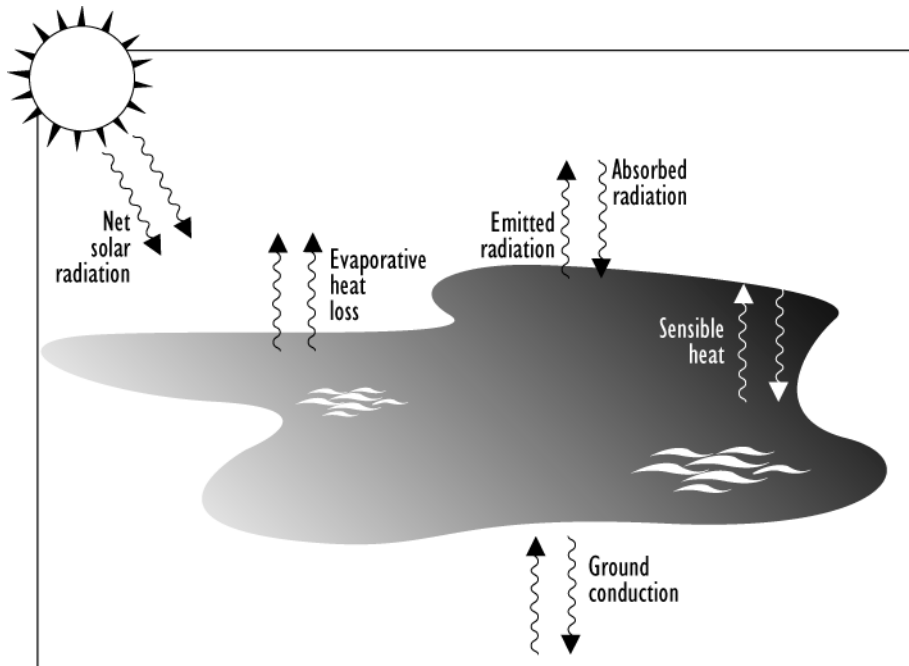
**Evaporating Puddle.** To model evaporation from a puddle, ALOHA accounts for the effects of wind speed, atmospheric turbulence, air temperature and pressure, viscosity, and other properties of the spilled chemical. It accounts for the effects on puddle temperature of solar heating, evaporative cooling, and several other ways in which heat is exchanged between a puddle and its environment. For example, on a sunny day, ALOHA will expect heat energy from the sun to warm the puddle. It expects puddle temperature to directly influence evaporation rate so that the higher the puddle temperature, the faster the evaporation rate. ALOHA accounts for changes in puddle temperature and, therefore, evaporation rate over time.

### What if the weather conditions change?

Bear in mind that wind speed and air temperature are important influences on evaporation rate. If these conditions change after ALOHA has estimated an evaporation rate, enter the new values and rerun ALOHA.

The types of heat transfer that ALOHA expects to affect puddle temperature fall into the following three categories:

- Incoming solar radiation (affected by location, time and date, and cloud cover);
- Heat transfer with the air (affected by air temperature, humidity, and initial puddle temperature);
- Heat transfer with the ground (affected by ground temperature, ground type, and initial puddle temperature).



**Figure 5-3.** Factors influencing ALOHA's puddle evaporation estimates.

ALOHA can model evaporation from puddles that are either boiling or that are cooler than the boiling point of the liquid that they contain. It cannot estimate *sublimation rate* for a frozen puddle (a frozen substance sublimates when it passes directly to the gas state without first becoming liquid).

**Area and Volume.** Enter the puddle area or, if the puddle is roughly circular, type its approximate diameter and ALOHA will estimate its area. If the puddle is roughly square or rectangular in shape, you must enter its area (equals to its length multiplied by its width). If the length and width are in units of feet, then the area will be in units of square feet; if the diameter or the length and width are in meters, the area will be in square meters, and so on. Puddle area strongly influences the evaporation rate (or burn rate if the puddle is burning). When all else is equal, the larger the area of a puddle, the higher is its evaporation rate or burn rate.

Next, enter the amount of chemical contained in the puddle. Specify the amount of liquid contained in the puddle by selecting:

- **Volume of puddle;**
- **Average depth of puddle;** or
- **Mass of puddle.**

Type a volume, depth, or mass value in the corresponding box and select the appropriate units.

**Ground Type and Initial Temperatures.** Next, for **evaporating puddles**, indicate the type of ground beneath the puddle. *Ground type* influences the amount of heat energy transferred from the ground to an evaporating puddle. Ground type is most important when the spilled liquid is **cryogenic**. Cryogenic liquids, such as refrigerated propane, are liquids which are stored at very low temperatures because they boil at temperatures well below ambient. As it estimates heat transfer from ground to puddle, ALOHA assumes that the ground does not absorb any of the spilled chemical, and that none of the chemical spilled onto water dissolves into the water.

ALOHA offers you five choices for ground type:

- **Default soil:** unwetted soil not covered by rock or concrete.
- **Concrete:** concrete, cement, asphalt, or otherwise paved surfaces.
- **Sandy dry soil.**
- **Moist sandy soil.**
- **Water:** lakes, oceans, or other large bodies of water.

**Note:** For ground type, descriptive terms like **dry** or **moist** refer to the state of the ground before the chemical was spilled—that is, the amount of water in the soil.



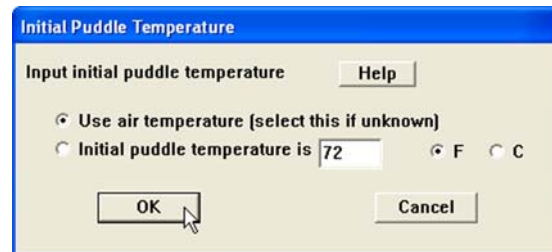
ALOHA expects heat to be transferred most readily from default ground or concrete surfaces into a puddle, and least readily from sandy ground. The heat transfer from water is generally greater than that of any of the other ground types.

Next, indicate the *ground temperature*, which influences the amount of heat transferred between the ground and the puddle. The warmer the ground, the warmer the puddle and the higher the evaporation rate. Type in a value for ground temperature, and choose either Fahrenheit or Celsius degrees. If you do not know the ground temperature, you can choose to estimate that it is about equal to the air temperature. In this case, click **Use air temperature (select this if unknown)**.

Air and ground temperatures can be very different in some situations, such as in a parking lot on a hot day late in the afternoon, or on a street during the early morning after a very cold night. Be sure to estimate air and ground temperatures carefully in such situations.

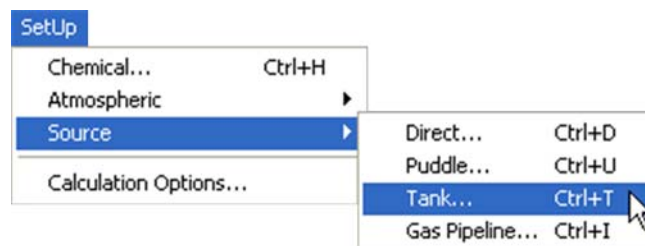
The last piece of information ALOHA needs is the initial puddle temperature. ALOHA assumes the initial temperature to be the same throughout the depth and width of the puddle. Indicate that the initial puddle temperature equals either the ground temperature or the ambient air temperature, or enter a value for the initial puddle temperature. Click the button that represents your choice. If your value for initial puddle temperature is above the liquid's normal boiling point, ALOHA will alert you and allow you to set the initial puddle temperature to the boiling point.

If the **puddle is burning**, you only need to enter the initial puddle temperature because ground type and ground temperature do not affect pool fire calculations. ALOHA assumes the initial temperature to be the same throughout the depth and width of the puddle.



## Tank

In the **SetUp** menu, point to **Source**, then select **Tank**. Choose the Tank source option to model releases of unpressurized liquids, liquefied gases, or pressurized gases from tanks or drums. ALOHA can model leaks that release the chemical directly into the atmosphere, as well as leaks that form an evaporating puddle. If the chemical is flammable, ALOHA can also model BLEVEs, pool fires, and jet fires.



You can choose to model releases from three types of tanks: a cylindrical tank lying on its side, a cylindrical tank standing on its end, or a spherical tank. ALOHA assumes any tank to be on level ground.

If the tank contains pressurized gas or liquid, ALOHA computes the change over time in pressure and temperature (as well as liquid volume) inside the tank as it leaks. If the tank contains unpressurized liquid, ALOHA assumes that gravity will drain the tank and that a puddle will form on the ground below the tank.

ALOHA cannot model a release in which there is both a pre-existing puddle on the ground and liquid continuing to leak from a tank into the puddle. If you encounter this situation, and the puddle is still spreading, choose **Tank** from the **Source** submenu to model the release as a tank leak. If the puddle has reached, or is about to reach, its maximum size, choose **Puddle** from the **Source** submenu to treat the release as a pre-existing puddle.

**Liquefied gases.** Both the liquid and gas phases of a chemical sometimes can escape together from a ruptured tank as a two-phase flow. Many substances that are gases under normal pressures and temperatures are stored under high enough pressures to liquefy them. For example, propane is a gas at normal pressures and temperatures but is often stored under pressure as a liquid. When a rupture or broken valve causes a sudden pressure loss in a tank of liquefied gas, the liquid boils violently, the tank contents foam up, and the tank fills with a mixture of gas and fine liquid droplets (called aerosol). When such a two-phase mixture escapes from the container, the release rate can be significantly greater than that for a purely gaseous release. **Note: ALOHA does not model the release of a liquid that has an overpressure applied to it from an inert gas.**

When liquefied propane or a similar chemical escapes from storage, it can form a heavy gas cloud. The cloud is heavy, in part, because it is initially cold and also because it consists of a two-phase mixture. The tiny aerosol droplets mixed into the cloud act to weigh the cloud down and make it denser, and their evaporation acts to cool the cloud.

When ALOHA predicts that a liquefied gas will escape as a two-phase flow, it alerts you with a message on the Text Summary: **Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).**

When you use ALOHA to model a release from a tank of a liquefied gas such as propane, generally ALOHA will predict that the substance will escape as a two-phase flow if the tank is pressurized. It treats ammonia and chlorine as special cases, however, because enough information about these chemicals is available to permit the use of more refined source strength calculations. When there is only a small amount of material in a tank, the hole in the tank is small, or the tank pressure is low, ALOHA predicts that these two chemicals will escape from storage as a pure gas, rather than as a two-phase flow.

**Tank Size and Orientation.** To model the release of a liquid or gas from a storage tank, you must indicate both the size of the tank and its general shape (which affects how it will drain). Choose the most appropriate of three tank types:

- **Horizontal cylinder;**
- **Vertical (upright) cylinder;** or
- **Sphere.**

Next, enter the tank's dimensions. If it is a cylinder, enter any two of the following three values: (a) diameter, (b) length, or (c) volume. If it is a sphere, enter either the tank's diameter or its volume. ALOHA will compute and display values for the remaining dimensions. Volume refers to the total volume of the tank, rather than the volume of chemical within the tank.

**Tank Size and Orientation**

Select tank type and orientation:

Horizontal cylinder  Vertical cylinder  Sphere

Enter two of three values:

diameter  length  volume

feet  meters

gallons  cu feet

OK Cancel Help

**Chemical State and Temperature.** Next you'll need to specify the state and temperature of the chemical in the tank. How the chemical is stored affects how the chemical may escape from the tank (as a pure gas, an unpressurized liquid, or a liquefied gas).

Click the button corresponding to one of the following options:

- **Tank contains liquid.** Choose this option if there is any liquid in the tank, even if it's just a small amount.
- **Tank contains gas only.** Choose this option if you know that the tank contains only gas, with no liquid present.
- **Unknown.** Choose this option if you don't know the chemical's state.

**Chemical State and Temperature**

Enter state of the chemical:  Tank contains liquid  Tank contains gas only  Unknown

Enter the temperature within the tank:  Chemical stored at ambient temperature  Chemical stored at  degrees  F  C

OK Cancel

Next, to enter the temperature within the tank, either:

- Click **Chemical stored at ambient temperature**, if the chemical is stored at the temperature of the surrounding air (you entered the air temperature when you entered atmospheric information), or
- Enter the storage temperature in the tank temperature data field (if the tank is at a different temperature), and indicate its units.

Whether a liquid is stored in a tank at a temperature above or below its boiling point greatly affects how it will escape through a tank rupture or leaking valve. If the liquid is stored below its boiling point, it will flow out of the tank, and form a puddle on the ground. If the liquid is stored above its boiling point, the pressure within the tank will be greater than atmospheric pressure. When such a tank is punctured, the liquefied gas contents may escape as a two-phase mixture of gas and aerosol. The rate of release can be significantly greater than the rate of release of an unpressurized liquid.

**Liquid in a tank.** Whenever you indicate to ALOHA that a tank contains liquid (by clicking **Tank contains liquid** when you are asked to identify chemical state), you will need to identify the amount of chemical in the tank in any of four ways: mass of chemical, liquid volume, percent full by volume, or height of liquid level in the tank. Choose to:

- Type the mass of the chemical in the tank (this should be the total mass of the liquid and its vapor in the tank);
- Type the volume of the liquid in the tank and indicate its units;
- Type your best estimate of the percent of the tank volume that is taken up by liquid as **% full by volume**; or
- Use the scroll bar next to the tank diagram to indicate the approximate height of the liquid level in the tank. Scroll up or down to position the horizontal bar on the diagram to indicate the liquid height. (If possible, check for a condensation line on the outer tank wall to get an estimate of the liquid level within the tank.)

**Liquid Mass or Volume**

Enter the mass in the tank OR volume of the liquid

The mass in the tank is:   pounds  
 tons(2,000 lbs)  
 kilograms

OR

Enter liquid level OR volume

gallons  
 cubic feet  
 liters  
 cubic meters

The liquid volume is:   % full by volume

**Gas in a tank.** Whenever you indicate to ALOHA that a tank contains only gas (by clicking **Tank contains gas only** when you are asked to identify chemical state), you will need to type either the tank pressure or the amount of gas in the tank.

Type a value for either the tank pressure or the amount of gas (either as mass or as volume at the Standard Temperature and Pressure of 1 atmosphere and 0°C), then select appropriate units. Click **OK**. If you enter a value for tank pressure, ALOHA will automatically estimate the mass in the tank. Once you have entered values for tank size, temperature, and either pressure or amount of chemical, ALOHA will check to be sure that the chemical is a gas. If the tank temperature is below the chemical's boiling point, or if the tank pressure is high enough to liquefy the chemical, ALOHA will warn you that your chemical is not a gas. If this happens, click **Cancel** to return to the previous dialog box, click **Tank contains liquid**, then continue.

**Chemical of unknown state in a tank.** If you are unsure whether a chemical in a tank is a gas or liquid (and you clicked **Unknown** when asked to identify chemical state), you will need a value for the total mass (weight) of chemical in the tank in order to run ALOHA. ALOHA uses this value, along with information about the chemical's properties and the temperature in the tank, to predict the chemical's state and the amount of chemical that could be released. Type in the mass of chemical in the tank, then select units of pounds, kilograms, or tons.

**Type of Tank Failure.** When you use the Tank source with a **flammable chemical**, ALOHA will ask you to specify the type of release. Select one of these three options:

- **Leaking Tank (Not Burning):** If a flammable chemical escapes from a tank and does not immediately burn, either the chemical will go directly into the air or it may form an evaporating puddle (depending on the storage conditions). In either case, a flammable vapor cloud will form. ALOHA can predict three possible hazardous outcomes: the toxic area of the vapor cloud, the flammable area of the vapor cloud (where igniting the cloud would cause a flash fire), and the overpressure (blast force) from a vapor cloud explosion.
- **Leaking Tank (Burning):** When a flammable liquid forms a burning puddle it is called a pool fire. When a flammable gas or an aerosol (two-phase flow) burns as it sprays from an opening in a tank, it is called a jet fire. Based on the storage conditions you specified, ALOHA will decide whether to model the chemical as a pool fire or a jet fire. Potential hazards associated with a pool fire or jet fire include thermal radiation, smoke, and toxic byproducts from the fire. ALOHA can help you model the thermal radiation hazard.
- **BLEVE (Boiling Liquid Expanding Vapor Explosion):** When a tank containing a liquefied gas fails completely, a BLEVE can occur. Some of the released chemical will burn in a fireball while the remainder will form a pool fire. The amount of the chemical involved in the fireball and/or the pool fire will depend on the conditions at the time of release. The primary hazards associated with a BLEVE are thermal radiation, overpressure, hazardous fragments, smoke, and toxic byproducts from the fire. ALOHA can help you model the thermal radiation hazard.

When you use the Tank source with a **nonflammable chemical**, ALOHA will automatically select the leaking tank (not burning) option and the toxic gas output (the only options for a nonflammable chemical). Although both flammable and nonflammable liquefied gases can be involved in BLEVEs, ALOHA only models flammable liquid BLEVEs.

If you choose either of the first two scenarios, you will need to enter information about the type of leak, beginning with the Area and Type of Leak dialog box. If you choose the BLEVE scenario, you may need to enter information about the fireball in the BLEVE Percent Mass in Fireball dialog box.

**Type of Tank Failure**

Scenario:  
Tank containing an unpressurized flammable liquid.

Type of Tank Failure:

Leaking tank, chemical is not burning and forms an evaporating puddle

Leaking tank, chemical is burning and forms a pool fire

BLEVE, tank explodes and chemical burns in a fireball

Potential hazards from flammable chemical which is not burning as it leaks from tank:

- Downwind toxic effects
- Vapor cloud flash fire
- Overpressure (blast force) from vapor cloud explosion

OK Cancel Help

**Percent Mass in Fireball.** When you model a BLEVE in ALOHA, it is assumed that part, or all, of the chemical forms a fireball, while the remainder burns as a pool fire. You can choose to either (a) estimate the percent mass of chemical in the fireball, or (b) enter the tank pressure or temperature and let ALOHA estimate the percent mass of the fireball.

**BLEVE Percent Mass in Fireball**

**BLEVE / Fireball Scenario:**  
The higher the internal tank pressure (or tank temperature) at the time of tank failure, the larger the fireball. Any liquid not consumed by the fireball will form a pool fire.

Enter one of the following:

Percentage of mass in the fireball: (55.1 % - 100%)  
 %

Pressure inside the tank at time of failure:  
  psia  mmHg  
 atm  Pa

Temperature inside the tank at time of failure:  
 degrees  F  C

OK Cancel Help

If you know the tank pressure or temperature at failure, enter either value and let ALOHA calculate the percentage of mass in the fireball. However, pressure and temperature are often difficult to determine. If you don't know those values, you can specify the percentage of mass in the fireball.

The percentage mass in the fireball must be greater than the minimum value supplied by ALOHA and no more than 100%. Choosing 100% will usually give you the worst-case scenario with the largest thermal radiation hazard. Based on the pressure and temperature of the tank at storage, ALOHA calculates the minimum amount of mass that would have gone into the fireball if the container failed at the storage conditions. **Note: If all of the mass goes into the fireball at storage conditions, ALOHA will automatically use 100% and skip this dialog box.** ALOHA displays the allowable range above the percentage mass in fireball value box.

The amount of chemical in the fireball will depend upon the pressure inside the tank when it ruptures. As the chemical is heated, the internal pressure in the tank increases—the higher the temperature, the higher the pressure, and the greater the size of the fireball. (Properly functioning relief valves may help limit the tank pressure and the size of the fireball.)

Both the nature of the chemical and the tank construction affect the size of the fireball. Tanks holding liquefied gases are designed to withstand high pressures and therefore pose a greater risk of a BLEVE. For typical propane tanks, the internal tank pressure under normal storage conditions is already high enough that 100% of the released chemical would form a fireball; no pool fire would form. While flammable liquids are typically stored in vessels less capable of withstanding high internal pressures, fireballs have been generated by the heat-induced rupture of such tanks.

When you model a BLEVE in ALOHA, three times the amount of the flammable chemical that flash-boils during the BLEVE is assumed to form a fireball, which includes both the chemical that flash-boiled and the chemical that was sprayed out as an aerosol during the explosion. The remaining liquid forms a pool fire. When ALOHA models a BLEVE situation including both a fireball and a pool fire, it estimates the thermal radiation from both fires; it is not necessary to run an additional Pool Fire scenario.

**Area and Type of Leak.** You must indicate the shape (circular or rectangular) and size of the opening in the leaking tank before ALOHA can calculate the rate of release of the tank's contents. You also must specify whether the release is through (a) a simple hole in the tank wall or (b) a short pipe or broken valve. A hole is any kind of break in the tank wall, such as a puncture or crack. The area of an opening is important to ALOHA, but its shape is used only to compute area. ALOHA predicts identical release rates through circular and rectangular openings, if they have the same area.

If your scenario is a release of pure gas from the tank, when you click **OK**, ALOHA will estimate the rate of release of gas from the tank. You will see a summary of the information that you entered, and the source strength results calculated by ALOHA. If at least some liquid is present in the tank, you will need to enter some more information on the Height of the Tank Opening dialog box before ALOHA can estimate source strength.

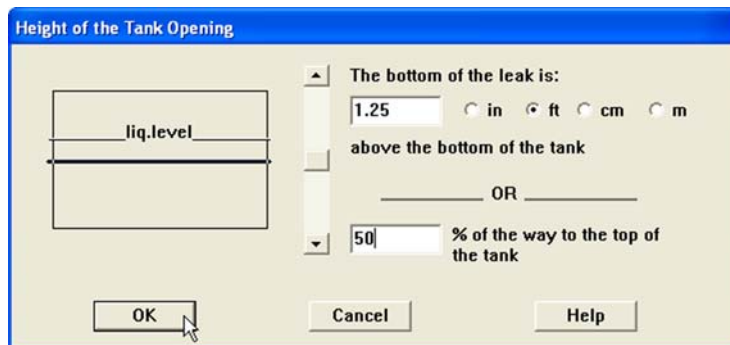
If the chemical is stored as a liquefied gas (a liquid at a temperature above its boiling point), ALOHA may expect it to escape from the tank under pressure as a two-phase mixture of gas and liquid. In liquefied gas cases, your choice of opening type can have an important effect on ALOHA's release rate computations. ALOHA will predict a higher release rate for a two-phase release if you choose the hole option rather than the short pipe/valve option. Opening type does not make a difference in a pure gas or unpressurized liquid release case.



**Height of the Tank Opening.** If there is liquid in the tank, you must tell ALOHA where the leak occurs on the tank. Enter a value for the height of the bottom of the leak (whether it is a hole, short pipe, or valve) above the floor of the tank. ALOHA uses this value to determine whether the leak is above or below the liquid level. If an unpressurized liquid is stored in the tank and the leak is below the liquid level, the chemical will spill out and form a puddle on the ground. It will stop spilling once the liquid level falls below the bottom of the leak. If the leak is above the liquid level and an unpressurized liquid is stored in the tank, ALOHA will report that no chemical is released. Regardless of the height of the leak, however, if the stored chemical is stored as a liquefied gas, it will escape through the opening directly into the atmosphere (without forming a puddle) as a two-phase flow of gas and aerosol (fine liquid droplets).

To indicate the height of the leak above the tank bottom, either:

- Type the height of the leak in distance units;
- Type the leak location as a percentage of the total distance from the bottom of the leak to the top of the tank (for example, 90% means that the leak is 90% of the way to the top of the tank); or
- Use the scroll bar to the right of the tank diagram to indicate the height of the leak on the tank wall.



If the chemical is an unpressurized liquid, you will need to enter some more information about the puddle that forms.

**Puddle formation.** If an unpressurized liquid leaks from a tank, an **evaporating puddle** may be formed. ALOHA will ask you for information about the area where the puddle will form. You will need to enter ground type and ground temperature, just as you would if you had selected the **Puddle** source option (however, in a Tank release case, ALOHA computes initial puddle temperature for you). You will also need to enter the maximum puddle diameter or area.

Ground type influences the amount of heat energy transferred from the ground to an evaporating puddle. Ground type is most important when the spilled liquid is **cryogenic**. Cryogenic liquids, such as refrigerated propane, are liquids which are stored at very low temperatures because they boil at temperatures well below ambient. As it estimates heat transfer from ground to puddle, ALOHA assumes that the ground does not absorb any of the spilled chemical, and that none of the chemical spilled onto water dissolves into the water.

ALOHA offers you five choices for ground type:

- **Default soil:** unwetted soil not covered by rock or concrete.
- **Concrete:** concrete, cement, asphalt, or otherwise paved surfaces.
- **Sandy dry soil.**
- **Moist sandy soil.**
- **Water:** lakes, oceans, or other large bodies of water.

**Note:** For ground type, descriptive terms like **dry** or **moist** refer to the state of the ground before the chemical was spilled—that is, the amount of water in the soil.

ALOHA expects heat to be transferred most readily from default ground or concrete surfaces into a puddle, and least readily from sandy ground. The heat transfer from water is generally greater than that of any of the other ground types.

Next, indicate the ground temperature, which influences the amount of heat transferred between the ground and the puddle. The warmer the ground, the warmer the puddle and the higher the evaporation rate. Type in a value for ground temperature, and choose either Fahrenheit or Celsius degrees. If you do not know the ground temperature, you can choose to estimate that it is about equal to the air temperature. In this case, click **Use air temperature (select this if unknown)**.

Air and ground temperatures can be very different in some situations, such as in a parking lot on a hot day late in the afternoon, or on a street during the early morning after a very cold night. Be sure to estimate air and ground temperatures carefully in such situations.

The last piece of information ALOHA needs is the maximum puddle area or diameter. If there are no barriers to prevent a puddle from spreading, click **Unknown**. For spills on land, ALOHA will expect the puddle to spread until it reaches an average depth of 0.5 centimeter (about 0.2 inch) up to a maximum diameter of 200 meters (220 yards). For spills on water, ALOHA will expect the puddle to spread until it reaches an average depth of 0.17 centimeter (about 0.07 inch). Unlike spills on land, there is no maximum diameter for spills on water. If there is a barrier to liquid flow (such as a containment or diked area), then type the approximate diameter of the barrier or area that it encloses. Select appropriate units, and click **OK**.

If an **unpressurized liquid** leaks from a tank and forms a **burning puddle**, you only need to enter the maximum puddle area or diameter because ground type and ground temperature do not affect pool fire calculations. **Note: ALOHA does not model pool fires on water.**

## Gas Pipeline

In the **SetUp** menu, point to **Source**, then select **Gas Pipeline**. Choose the Gas Pipeline source option to model the release of a gas from a leaking gas pipeline. (If the chemical is flammable, the release can be modeled as a jet fire as well.)



You can use ALOHA to model two types of gas pipeline leak scenarios:

- A pipeline connected to a very large (**infinite**) reservoir, so that gas escapes from the broken end of the pipeline at a constant rate for an indefinite period of time; or
- A finite length of pipeline that is closed-off at the unbroken end (for example, by a shut-off valve). Because the pressure within this section of pipe declines as gas is released, release rate drops over time, and the release continues only until the finite length of pipe is emptied. **ALOHA cannot model gas release from a pipe that has broken in the middle and is leaking from both broken ends.**

**Pipe source inputs.** To describe a Gas Pipeline release to ALOHA, type the pipe diameter and length, indicate whether the pipe is connected to a reservoir, indicate whether the inner pipe surface is smooth or rough, type pipe pressure and temperature, and type the area of the hole (if the pipe is of finite length).

- **Pipe diameter and length.** Use the inner diameter of the pipe. The pipe length must be at least 200 times the diameter of the pipe.
- **Pipe connection.** Indicate whether the pipe is connected at its unbroken end to a large reservoir (infinite tank source), or is closed-off.
- **Pipe roughness.** Degree of roughness of the inner surface of the pipe. A smooth pipe would be, for example, a new metal, glass, or plastic pipe. A rough pipe would be, for example, a metal pipe with a rusted inner surface or a pipe that has been corroded on the inside by the chemicals it carries. Rough texture causes turbulence, which reduces the flow rate of the gas in the pipe. A gas will flow more slowly through a rough pipe than through a smooth pipe.

 A screenshot of a dialog box titled 'Gas Pipeline Input'. It contains four sections:
 

- Input pipe diameter:** 'Diameter is' followed by a text box containing '12', radio buttons for 'inches' (selected) and 'cm', and a 'Help' button.
- Input pipe length:** 'Pipe length is' followed by a text box containing '1212', radio buttons for 'ft' (selected), 'yds', and 'meters', and a 'Help' button.
- The unbroken end of the pipe is:** Radio buttons for 'connected to infinite tank source' (selected) and 'closed off', and a 'Help' button.
- Select pipe roughness:** Radio buttons for 'Smooth Pipe' (selected) and 'Rough Pipe', and a 'Help' button.

 At the bottom are 'OK' and 'Cancel' buttons. A mouse cursor is pointing at the 'OK' button.

- **Pipe pressure.** If the pipeline is connected to a very large (infinite) reservoir, use the pressure within the reservoir as your value for pipe pressure. If gas is escaping from a finite, closed-off section of pipeline, enter the pressure within that pipe section.
- **Pipe temperature.** Indicate the temperature of the pipe contents in either of two ways: (a) click **Unknown (assume ambient)** if you do not know the temperature (ALOHA will then use the ambient air temperature), or (b) type the temperature of the pipe's contents in the pipe temperature box, then select appropriate units (either degrees Fahrenheit or Celsius).

- **Hole size.** If the pipeline is connected to a very large (infinite) reservoir, ALOHA assumes that the pipe has been completely sheared-off, so that the hole diameter equals the pipe diameter. If only a closed-off length of the pipeline is leaking, you can choose to (a) allow ALOHA to use the pipe diameter as its value for the hole diameter, or (b) enter a value for the area of the hole, if the hole is smaller in area than the pipe diameter.

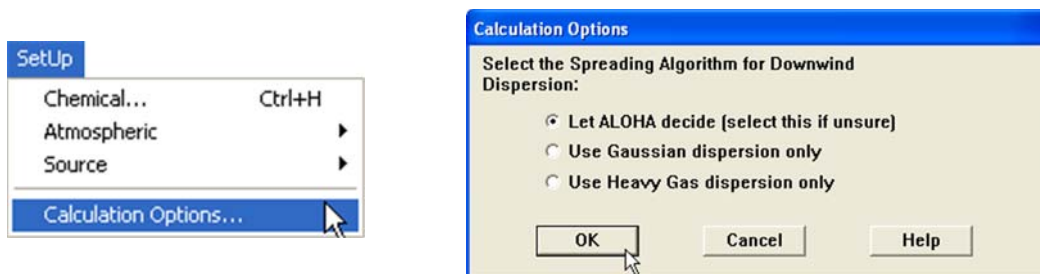
**Source strength information in the Text Summary.** Regardless of the source option you choose, once you have entered all necessary inputs and clicked **OK** on the last source strength dialog box, ALOHA estimates source strength. It then displays the source input values you entered and the results of its calculations in the Text Summary. For example, for non-burning sources, you might see the following information:

- **Source type.** A brief description of the type of source modeled, for example, **Flammable gas escaping from pipe (not burning)**.
- **Release duration.** The length of time, in minutes, during which the chemical is predicted to continue to escape into the atmosphere. If ALOHA predicts the release to continue for more than an hour, you'll see the message **Release Duration: ALOHA limited the duration to 1 hour**.
- **Total amount released.** This is the amount of chemical that ALOHA predicts will be released into the atmosphere during the hour after a release begins (not the amount of liquid that spills from a tank during that time).

Review the information you have entered as it appears in the Text Summary, to be sure that you made no errors when entering information. Review the source type, predicted release rate, duration, and total amount released to be sure that this information seems reasonable to you. If it does not, try to obtain more information about the release in order to more accurately model it.

## Calculation Options

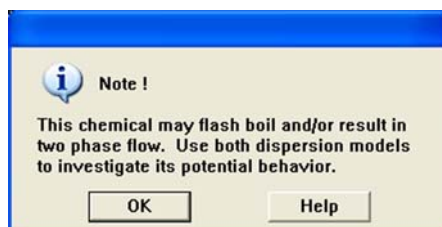
Choose **Calculation Options** from the **SetUp** menu to select the type of dispersion calculation used.



You can choose from among three dispersion calculation options:

1. **Let ALOHA decide.** When you select this option, ALOHA automatically chooses whether to predict the dispersion of a chemical as a Gaussian (neutrally buoyant) or heavy gas release. It bases this choice mainly on molecular weight, size of the release, and temperature of the gas cloud. By default, this option remains selected unless you choose a different option. When “Let ALOHA decide” is selected, if ALOHA’s chemical library does not include values for all physical properties of your selected chemical necessary to make heavy gas dispersion calculations, ALOHA will use Gaussian dispersion calculations to predict threat zone size.

When a chemical with a molecular weight less than that of air has been stored at a low temperature or under high pressure, it can behave like a heavy gas (ammonia is an example of such a chemical). If you have chosen one of these chemicals and have chosen the Direct source option, ALOHA may not have enough information about the release to determine whether a heavy gas could be formed. In such a case, ALOHA will make Gaussian calculations, but will alert you that you should try running the heavy gas model as well.



2. **Use Gaussian dispersion only.** Choose this option if you know that the escaping gas cloud is approximately neutrally buoyant (about as dense as air). ALOHA will use the Gaussian equation to predict the spread of the cloud. Avoid using ALOHA’s Gaussian model to predict how a large heavy gas cloud will disperse. Large gas clouds that are denser than air (heavy gases) disperse in a very different way than this model would predict. They are affected by gravity and other forces besides wind and turbulence. As they move downwind, they remain much lower to the ground than neutrally buoyant clouds, and flow like water. Ground-level concentrations within such clouds may reach much higher levels at some locations than the Gaussian model would predict.

3. **Use Heavy Gas dispersion only.** Choose this option if you know that the cloud is heavier or denser than air. You will be alerted if ALOHA does not have enough property information to make heavy gas calculations for your selected chemical. To see a list of the properties needed for heavy gas calculations, check Table 5-1. (To view the property values in the library for your selected chemical, choose **Chemical** from the **SetUp** menu, then click **Modify**.) When you choose Use Heavy Gas dispersion only, ALOHA will predict the dispersion of the pollutant using the heavy gas computations.

Typically, when the atmosphere is most unstable (stability classes A and B), heavy gas threat zones will be longer than Gaussian threat zones. When the atmosphere is most stable (stability classes E and F), Gaussian threat zones will be longer. Under neutral (C and D) conditions, heavy gas and Gaussian threat zones will be similar in length.

## Display menu

Select items from the Display menu to indicate the ALOHA results that you would like to see and how you would like the information to be displayed:

- Choose **Threat Zone**, **Threat at Point**, **Text Summary**, and/or **Source Strength** to display the corresponding windows.
- Choose **Tile** or **Stack** to organize ALOHA's windows on your screen.
- Choose **Display Options** to have ALOHA's output displayed in either English or metric units.

Display	
Threat Zone...	Ctrl+F
Threat At Point...	Ctrl+R
Text Summary	Ctrl+K
Source Strength	Ctrl+G
Tile Windows	
Stack Windows	
Display Options...	Ctrl+Y

## Threat Zone

Choose **Threat Zone** from the **Display** menu to have ALOHA create a threat zone plot, where up to three hazard levels are plotted based on your Levels of Concern (LOC). Once you select Threat Zone from the Display menu, you must specify one or more LOCs.

**Note:** For flammable vapor clouds, ALOHA can model three different hazards (toxic area, flammable area, and blast area). If you are modeling a flammable vapor cloud (or a situation where such a cloud might form), a **Hazard To Analyze** dialog box will appear after you choose **Threat Zone** from the **Display** menu. In this dialog box, you must first select the hazard that you want ALOHA to model before you can choose your LOCs. Additionally, if you select blast area from a vapor cloud explosion, you will have to complete the **Vapor Cloud Explosion Parameters** dialog box before you can choose your LOCs.

**Level of Concern.** A Level of Concern (LOC) is a threshold value of a hazard (toxicity, flammability, thermal radiation, or overpressure); the LOC is usually the value above which a threat to people or property may exist. You may keep ALOHA's default values as your LOCs, or you may choose up to three of your own LOCs. For each LOC you choose, ALOHA estimates a threat zone where the hazard is predicted to exceed that LOC at some time after a release begins.

You may designate LOC values in one of three ways:

- Use ALOHA's default LOC choice.
- Use the LOC pulldown menus to choose another LOC from the list.
- Select **User specified** from the LOC pulldown menu and enter your own temporary LOC value and select the appropriate units.

**Note:** You can add your own default Toxic LOC for any pure chemical in ALOHA's chemical library. ALOHA will then use your LOC by default rather than its Toxic LOC defaults for the selected chemical. To permanently add your own default LOC, choose **Chemical** from the **SetUp** menu, click to highlight the name of the chemical in the list, then click **Modify**. In the list of physical properties, click **Default Level of Concern**, then type your LOC values in the "Default LOC Value - 1, - 2, -3" boxes. Choose the appropriate units (either parts per million or milligrams per cubic meter), then click **OK**.

For toxic releases, there are several hazard classification systems in use. Some chemicals have not been classified in every system. ALOHA determines its default toxic LOC values based on the following hierarchy of well-known LOCs:

1. AEGL
2. ERPG
3. TEEL
4. IDLH

**Note:** For AEGLs, ERPGs, and TEELs, the rank number increases with the hazard level, so that **AEGL-3 is more hazardous than AEGL-1. Typically, the "-3" values are used for the most hazardous (red) threat zones because they represent the threshold concentration above which health effects may be life threatening.**

**Vapor Cloud Explosion Parameters.** The severity of a vapor cloud explosion depends on many factors, including the chemical, the cloud size at the time of ignition, the type of ignition, and the congestion level in the flammable area of the vapor cloud. Before ALOHA can generate a threat zone plot for a vapor cloud explosion, you must complete the Vapor Cloud Explosion Parameters dialog box.

Begin by filling in the **ignition time**. The ignition time represents the length of time that the cloud mixes with the air around it and becomes diluted in concentration. Therefore, the amount of the vapor cloud that is between the Lower and Upper Explosive Limits (LEL and UEL) will depend on the ignition time. Enter the time in minutes or seconds. If you do not know the ignition time, ALOHA allows you to choose an **unknown ignition time** option.

If you choose the unknown ignition time option, ALOHA will run explosion scenarios for a range of ignition times that encompass all of the possible ignition times for your scenario. ALOHA takes the results from all of these scenarios and combines them on a single threat zone plot. The threat zone in this case does not represent the blast area from a single explosion, but rather the composite of potential blast areas for all of the different ignition time scenarios that ALOHA ran.

**Note:** If you are modeling an instantaneous release from a Direct source, ALOHA models the chemical release for 60 seconds. If you choose an ignition time less than 60 seconds, not all of the chemical will be released prior to the explosion.

Next, choose the **ignition type**. The type of ignition source has a big influence on the severity of the explosion. Accidental explosions are most often triggered by common ignition sources, such as sparks, flames, heat, and static electricity. Accidental explosions are generally deflagration explosions. Explosions that are triggered by detonation (usually by a high-power explosive device) are detonation explosions, which are far more damaging than deflagration explosions. Under rare circumstances, an accidental explosion can be triggered by a common ignition source and still become a detonation explosion.

If you know the ignition type, choose the appropriate option. If you are using ALOHA for planning purposes, consider modeling both types of ignition. Choose the **ignited by spark or flame** option if you want to model a typical accidental explosion. Choose the **ignited by detonation** option if you want to model an intentional explosion or a worst-case accidental explosion.

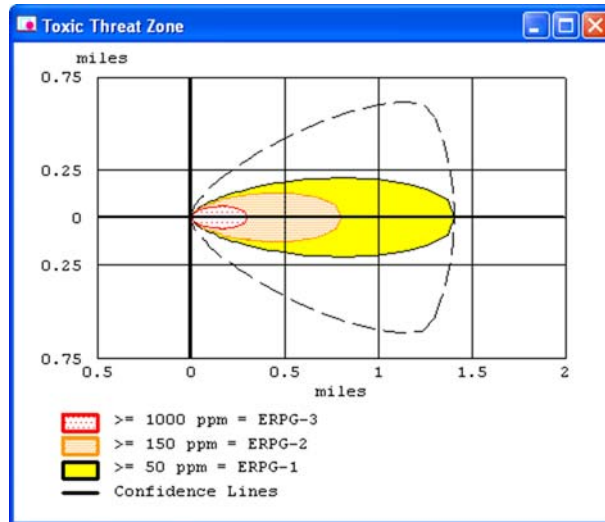
Finally, choose the **congestion level** within the majority of the vapor cloud. Congestion refers to the density of obstacles that generate turbulence. Obstacles of this nature are generally small, like a shrub, and do not impede the flame front. Larger objects, like a building, can impede the flame front, so they should not be considered obstacles for the purposes of congestion. Greater turbulence allows the flame front to accelerate, thereby generating a more powerful blast wave (i.e., greater overpressure).



ALOHA uses two congestion levels: **congested** and **uncongested**. Generally, a congested zone has so many closely spaced obstacles that it is difficult or impossible to walk through it. It is uncommon for this level of congestion to be found throughout the entire vapor cloud. However, pipe racks in industrial facilities and some forested areas (where the trees and branches are closely spaced) may be characterized as congested areas. Uncongested zones include: parking lots, open fields, suburban neighborhoods, and most urban environments.

Choose the level of congestion (congested or uncongested) in the flammable area of the vapor cloud—that is, the part of the vapor cloud where the concentration is between the LEL and UEL. If there is more than one congestion level in the flammable area of the vapor cloud, choose the level that best represents the majority of the area. Click **OK**. An Overpressure Level of Concern dialog box appears.

**Threat zone plot.** Once you have entered all necessary information about a release and chosen an LOC, ALOHA will display a threat zone plot based on the LOC(s) that you specified. If three LOCs are chosen, ALOHA will display the threat zones in red, orange, and yellow, overlaid on a single plot. By default, the red zone represents the worst hazard. (The pattern of dots also varies for each threat zone so that you can differentiate between the zones if you are color blind or the plot has been printed in black and white.)



On ALOHA's threat zone plot for all dispersion scenarios, the dashed lines along both sides of the threat zone represent uncertainty in the wind direction. The wind rarely blows constantly from any one direction. As it shifts direction, it blows the released chemical in a new direction. The "uncertainty lines" around the threat zone enclose the region within which, about 19 out of 20 times, the chemical cloud is expected to remain. The lower the wind speed, the more the wind changes direction, so as wind speed decreases, the uncertainty lines become farther apart. They form a circle when wind speed is very low.

**Interpreting a threat zone.** ALOHA's threat zone estimate represents its "best guess" of what will happen downwind of a chemical release. It's not an exact prediction of just where the gas cloud will travel and how large it will be. As you examine any threat zone plot, remember the many uncertainties involved in trying to predict the effects of a chemical release:

- When you enter information into ALOHA, you often have to guess at some of the necessary inputs.
- Many things that happen by chance—such as unexpected changes in wind speed or direction during a release—can influence how a gas cloud disperses, but are not accounted for in ALOHA's computations.
- Although ALOHA is a relatively complex computer program (it contains thousands of lines of computer code), reality is much more complex. ALOHA makes simplifying assumptions in order to make its predictions. Try to identify ways in which reality may be different from what ALOHA assumes. For example, ALOHA expects the terrain under a dispersing gas cloud to be flat and free of obstacles, but in the real world, that's rarely the case.

Treat any threat zone plot as a "ballpark estimate," and always use it along with—never instead of—your own judgment, experience, and observations, when you make response or planning decisions.

**Displaying threat zones in other applications.** Threat zones can also be overlaid on electronic maps displayed in ALOHA's companion mapping application, MARPLOT.

You can also import an ALOHA threat zone plot into either of two Geographic Information System (GIS) products manufactured by ESRI: ArcView and ArcMap. To import a threat zone plot, you will need to download and install the appropriate plugin from NOAA's Office of Response and Restoration Web site: <http://response.restoration.noaa.gov/cameotoolkit>.

## Threat at Point

Once you have displayed a hazard—toxicity, flammability, thermal radiation, or overpressure—on a threat zone plot, you can use the Threat at Point option to obtain specific information about the hazard at a point of interest (such as a school or hospital) in or around the threat zones.

You can find the threat at a point by either:

- Selecting **Threat at Point** from the **Display** menu; or
- Double-clicking on a location on the threat zone plot.

**Note:** If ALOHA was unable to generate a Threat Zone plot, you can still look at the threat at a point by selecting Threat at Point from the Display menu.

If you select **Threat at Point** from the **Display** menu, a dialog box will appear and you can define the point where you would like to obtain a threat estimate using either of two types of location coordinates—fixed or relative coordinates. Your choice of coordinates will affect the information ALOHA will present to you if the wind changes direction (whether you're using a SAM, or you manually enter a new value).

**Using fixed (east-west and north-south) coordinates.** Choose this option if you wish to know the hazard expected at a specific geographical location. This could be, for example, a school 100 yards to the west and 400 yards to the north of the release location. This is the best method to choose if you wish to monitor the expected hazard at the school, and you are using a SAM to track wind speed and direction in ALOHA. If the wind shifts direction, the results displayed by ALOHA may change, depending on whether or not the shift in wind direction moves the pollutant cloud closer to the school or farther away from it.

**Using relative (downwind and crosswind) coordinates:** Choose this option when you wish to know the hazard expected at a position that can best be described in terms of its downwind and crosswind distance from the release point. For example, suppose that you have estimated the straight-line distance between the site of a release and a nearby hospital to be a quarter-mile. At the moment, the wind is not blowing the chemical cloud directly towards the hospital, but the wind is variable in direction. You wish to know the hazard value you could expect if the wind were to shift and carry the cloud of escaping chemical directly towards the hospital. To get that estimate, you would use ALOHA to obtain threat at a point results for a location a quarter-mile downwind and with a crosswind distance of 0 miles. These results represent the worst-case hazard levels that could develop at any point one quarter-mile downwind of the source, should the wind shift to blow the cloud towards that point.

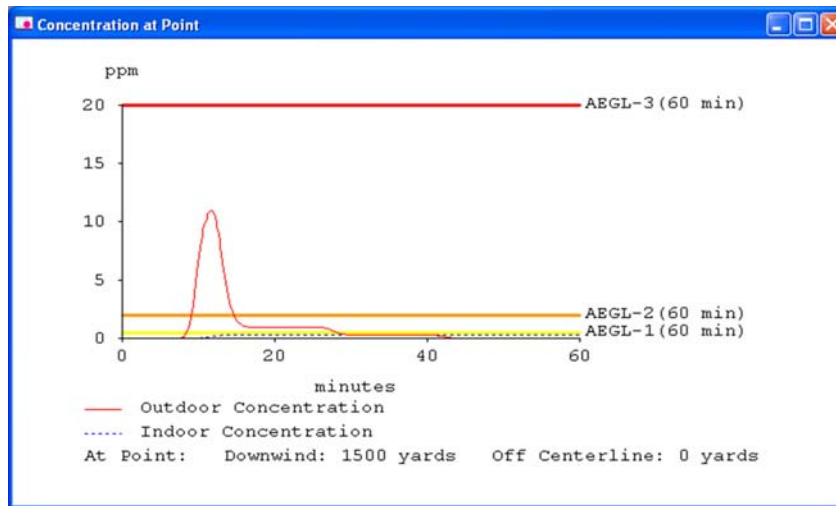
**Note:** When you use relative coordinates, ALOHA will remember the location of the point that you have specified in terms of its downwind and crosswind distance to the source. Therefore, the geographic location of the point that you have specified to ALOHA will move when the wind direction changes. A point specified in this manner “follows the wind.”

If you select your **Threat at Point** by double-clicking on its location within the threat zone window, ALOHA will use relative coordinates to track your location.

**Threat at Point results.** Once you designate a location, ALOHA will display its estimate of the threat at a point either as a graph or as text. For example, if you choose to see the threat at a point for a toxic gas dispersion scenario, ALOHA will display a Concentration at Point graph.

The Concentration at Point graph displays ground-level chemical concentrations in indoor and outdoor air at the specified location during the first hour after the beginning of a chemical release. The concentrations shown on the graph are averaged over a few minutes; they are not instantaneous values. Gas concentrations can fluctuate greatly over time periods of several seconds. The maximum peak concentration can significantly exceed the maximum averaged concentration shown on the graph.

There may be up to five lines visible on the graph. The thin red line represents the outdoor, ground-level concentration. The dashed blue line represents concentration within a building of the type you selected. To compute indoor concentration, ALOHA assumes that all doors and windows are closed. If applicable to your chosen location, there may also be up to three horizontal lines (red, orange, and yellow) representing the LOCs. The red horizontal line represents the worst hazard level.



In the Concentration at Point graph above, ALOHA predicts that a cloud of chlorine gas would arrive at the location in about 7 minutes (that's when the outdoor concentration line begins to rise steeply on the graph). Notice that the indoor concentration is predicted to remain much lower than the outdoor concentration, as long as the building's door and windows are closed. ALOHA predicts that outdoor concentration would exceed one LOC (AEGL-2) only briefly, but will exceed a lower LOC (AEGL-1) for much longer.

The indoor concentration does not exceed any of the LOC values; however, it does approach the AEGL-1 LOC for a significant period of time. At this level, people inside the building may begin to experience notable discomfort, irritation, or other temporary effects. Bear in mind that no LOC represents an exact line between hazardous and non-hazardous conditions, because people differ in their sensitivity to chemicals (for example, old, sick, or very young people may be more sensitive to chemicals than healthy adults) and other hazards. People who are more sensitive to the chemicals may experience more serious health effects than those predicted for the AEGL-1 level, even though that level was not exceeded in the hour after the release.

**Note:** ALOHA will place a blue crosshair mark on the threat zone plot to indicate the location where the hazard is evaluated. If you have plotted the threat zones on a map in MARPLOT, ALOHA will place the crosshair mark on the map as well.

**What if the doors and windows are open?**

To estimate the rate at which pollutant gas could infiltrate into buildings, ALOHA assumes that all doors and windows are closed. If doors and/or windows are open, as they might be on a warm summer day, concentrations might increase more rapidly and drop off sooner inside buildings than ALOHA's indoor concentration line indicates.

**Text Summary**

Select **Text Summary** from the **Display** menu to bring the Text Summary window forward when other ALOHA windows appear in front of it. ALOHA's Text Summary contains information about the scenario you are working on. Review its contents to see summaries of:

- Information that you have entered into ALOHA;
- Some basic properties of the chemical you have selected;
- Results of ALOHA's calculations;
- Messages indicating the information that you still need to enter; and
- Additional notes describing any special circumstances that may exist.

The Text Summary window remains open whenever ALOHA is running. Review its contents periodically as you prepare a scenario to ensure that you have entered model inputs correctly, and to check the results of ALOHA's calculations. Choose **New** from the **File** menu when you want to clear existing Text Summary information before beginning a new scenario.

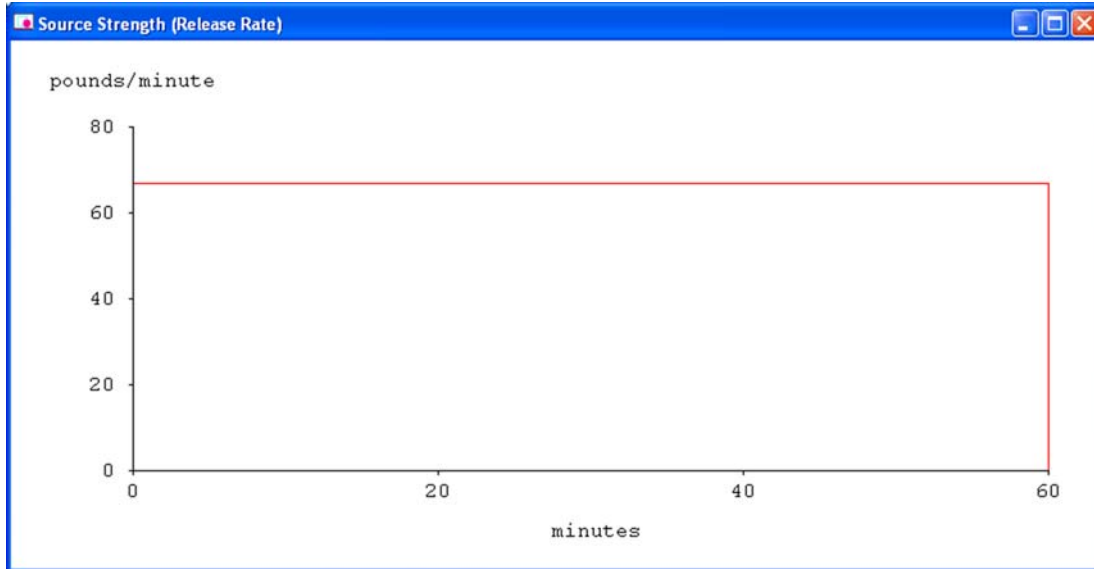
**Source Strength**

Choose **Source Strength** from the **Display** menu to see either the rate at which the chemical enters the atmosphere or the burn rate, depending on the scenario. When you choose this menu item, ALOHA displays a graph showing the rate (source strength) predicted for the first hour after a release begins or until the release is complete, whichever is shortest.

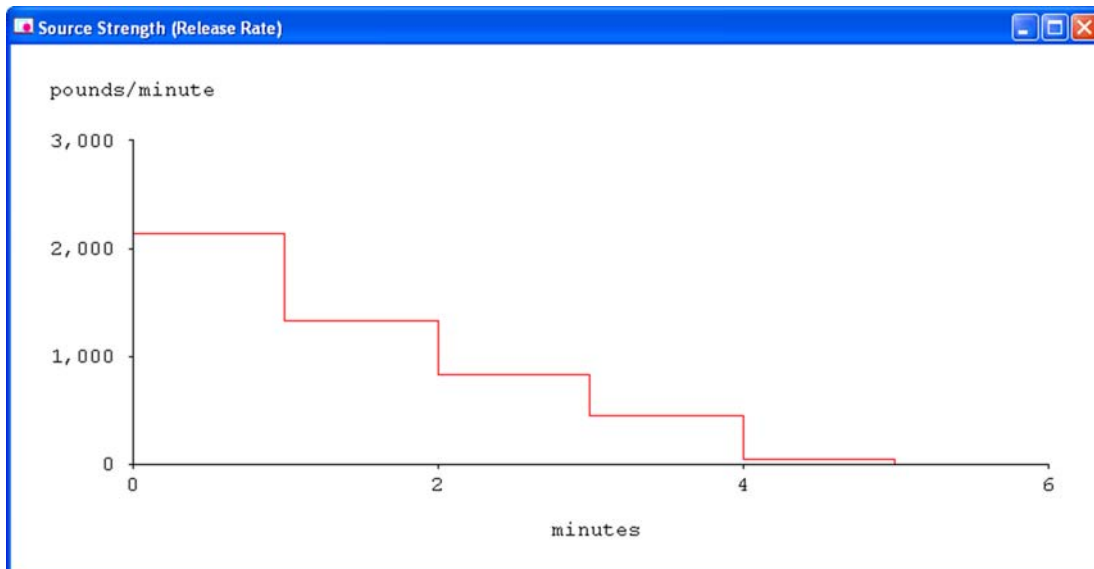
**Note:** ALOHA does not display a source strength graph for BLEVE scenarios.

ALOHA produces two main types of source strength estimates, depending on the type of release that you have chosen. Source strength graphs for the two types of estimates differ in appearance.

**Constant source strength.** Release rate for a **Direct** source, whether it's instantaneous or continuous, will remain constant for the duration of the release. ALOHA expects an instantaneous release to last for 1 minute, and a continuous release to last for up to 1 hour. Graphs of either type of Direct release look like the plot shown below.



**Variable source strength.** Source strength predicted by the Puddle, Tank, or Pipe source options can change over time. For example, consider the rate of release of a pressurized gas from a tank rupture. Initially, the chemical escapes rapidly through the rupture. As the tank pressure drops, the rate of release slows. If you model such a release using ALOHA, you'll see a line that descends in steps on the source strength graph.



**Source strength averaging.** ALOHA predicts source strength as a series of hundreds of brief timesteps. These values must be averaged into fewer steps so that calculations can be completed quickly. For releases into the atmosphere, ALOHA averages the series of timesteps into between one and five release rates that are each for a time period of at least 1 minute. For burn rates, ALOHA averages over timesteps lasting 20 seconds. The series of averaged steps is shown on the Source Strength graph, since this is the information used to calculate the threat zones.

## Tile and Stack Windows

The **Tile** and **Stack Windows** options allow you to organize the information windows on your computer screen.

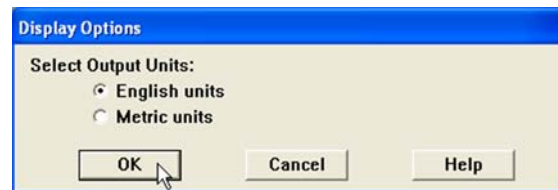
- Choose **Tile Windows** when you wish to see all of ALOHA's open windows at once (rather than overlapping each other in a stack). Windows will be reduced in size and arranged in rows and columns as necessary to fit on your screen.
- Select **Stack Windows** when you wish to arrange ALOHA's windows on your screen so that each overlaps the next, with only the front window fully visible. The title bars of the remaining windows will remain visible.

You may resize or move any ALOHA window after you have chosen either option.

## Display Options

Choose **Display Options** from the **Display** menu to have ALOHA output displayed in either:

- **English units**, such as pounds, yards, and miles, or
- **Metric units**, such as grams, kilograms, meters, and kilometers.



Click either English units or Metric units. ALOHA will display the results of its computations in the type of units (English or metric) that you choose. It will display input values in the units that you selected when you entered the values. For example, if you entered wind speed in miles per hour (an English unit), you will see wind speed displayed in those units on the Text Summary screen, even if you selected metric output units.

## Sharing menu

The programs that make up the CAMEO (Computer-Aided Management of Emergency Operations) package work together by means of the **Sharing** menu. Any application that can communicate with ALOHA can install a menu under ALOHA's Sharing menu. A menu installed by another application into the ALOHA Sharing menu belongs to the installing application. Both CAMEO and MARPLOT automatically install menus under ALOHA's Sharing menu.

ALOHA automatically saves menus that other applications have placed in its Sharing menu. When you use a saved menu that belongs to an application that is not currently running, ALOHA will start that application so that it can carry out the specified action. You can delete a menu from the Sharing menu if you wish (you might want to do so if you remove an application from your hard drive). To do this, choose **Edit Shared Menus** from the **Sharing** menu, select the menu that you wish to delete, then click **Delete**.

### Items in the Sharing menu

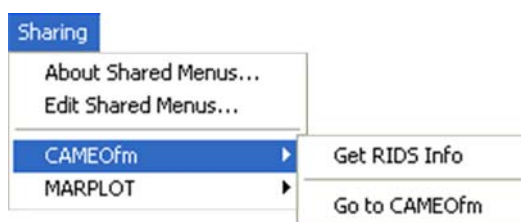
Two items always appear in the Sharing menu, whether or not ALOHA is sharing information with another program:

- Choose **About Shared Menus** to view on-screen help information about information sharing between ALOHA and other programs.
- Choose **Edit Shared Menus** to delete an application's menu from the Sharing menu.

### CAMEO menu

When CAMEO is running, a CAMEO menu appears in ALOHA's Sharing menu. The CAMEO menu in ALOHA's Sharing menu contains two items:

- If you have selected a chemical in ALOHA, choose **Get RIDS Info** to see information about this chemical in CAMEO's RIDS (Response Information Data Sheets) database.
- Choose **Go to CAMEO** to start CAMEO or to go to CAMEO if it is already running.

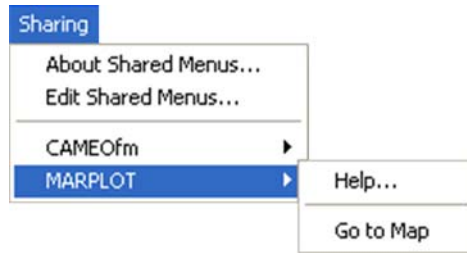




## MARPLOT menu

The MARPLOT menu in ALOHA's Sharing menu contains two items:

- Choose **Help** to learn about information-sharing between MARPLOT, CAMEO's mapping program, and ALOHA.
- Choose **Go to Map** to start MARPLOT or to go to MARPLOT if it is already running.



Use MARPLOT with ALOHA to display an ALOHA threat zone plot on an electronic map of your community.

MARPLOT can display several different types of maps. It was primarily designed to use special maps generated from TIGER (Topologically Integrated Geographic Encoding and Referencing) files, prepared by the U.S. Census Bureau from U.S. Geological Survey base maps. TIGER files are computer-readable geographic data bases for all U.S. states, territories, and possessions. They include digital descriptions of features such as political boundaries, water bodies, transportation routes, and address ranges for street segments. MARPLOT-readable maps incorporating this TIGER information can be downloaded from the CAMEO download Web site (<http://www.epa.gov/cameo/marmaps>). Check your MARPLOT manual for more information about obtaining and using maps.

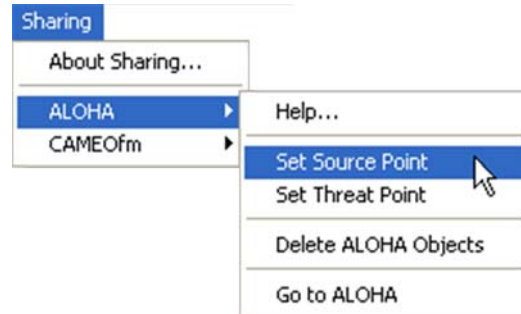
## Using MARPLOT

When ALOHA and MARPLOT are running simultaneously, ALOHA automatically installs a menu in MARPLOT's Sharing menu. You can choose items from this menu to indicate the location of a release, display an ALOHA threat zone plot on a MARPLOT map, or indicate a location for which you would like specific hazard information.

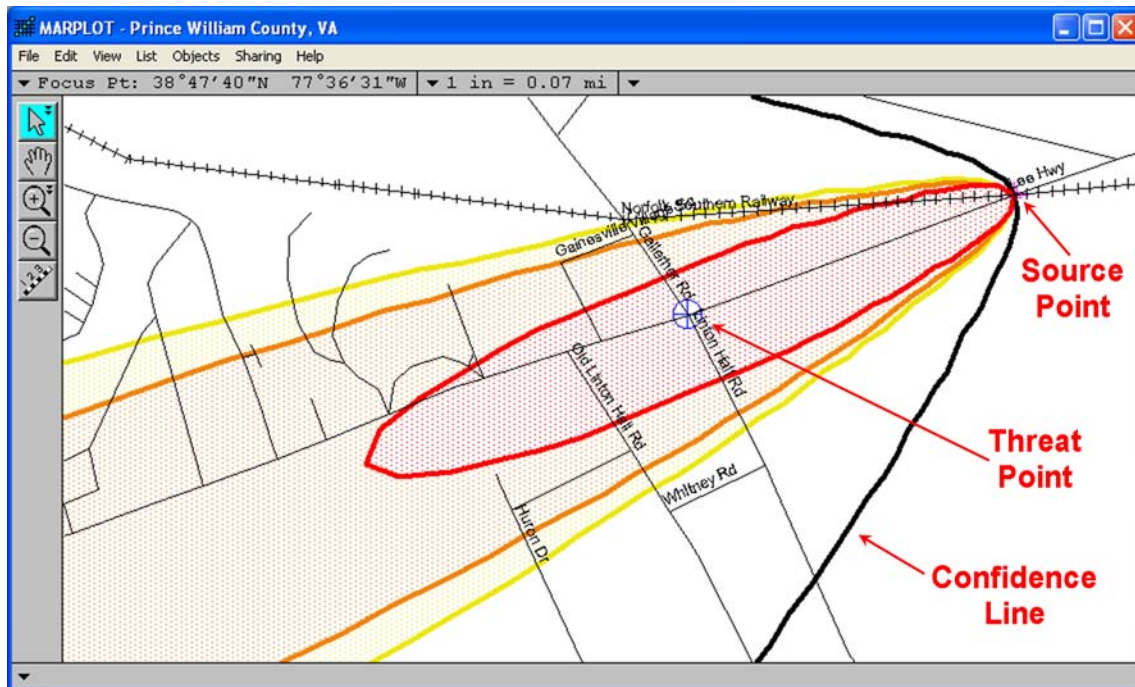
Choose from among the following items contained in the ALOHA submenu:

- **Help:** Choose Help to see a discussion about using MARPLOT together with ALOHA.

- Set Source Point:** First, click once on the location of an accidental chemical release on your MARPLOT map; this is the source point. Next, choose **Set Source Point**. ALOHA will place a pink cross symbol at the source location. Once a threat zone has been displayed in ALOHA, ALOHA's threat zone, as well as the wind direction confidence lines around it, will automatically be drawn on the map in MARPLOT. If you already designated a **Threat at Point** in ALOHA, that location will be marked by a blue crosshair mark on the map in MARPLOT. **Note: If you are using an older version of MARPLOT, the orange threat zone will be displayed as a green threat zone by default.**



- Set Threat Point:** First, click the location on your MARPLOT map for which you wish to see threat information. Next, choose **Set Threat Point** to tell ALOHA the location. ALOHA will place a symbol at that location, then come forward to make concentration calculations and display the Threat at Point plot. ALOHA will use fixed (east-west, north-south) coordinates to remember the point's position.
- Delete ALOHA Objects:** Choose this item to remove all objects placed on the map by ALOHA. ALOHA then will no longer update the map every time it generates new information.
- Go to ALOHA:** Choose this item to bring ALOHA forward.



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# Troubleshooting

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Often, when you encounter difficulties while running ALOHA, it will alert you of the problem and suggest a solution. At other times, you may encounter a problem and not know how to solve it. Below are some of these cases. For more ALOHA information, check the ALOHA Web site at <http://response.restoration.noaa.gov/comeo/aloha.html>.

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**In the Text Summary, I see tank volume estimated to be “5.2e8 gallons.” How many gallons is that?**

ALOHA displays its results in *exponential notation* whenever numbers are too large to display in decimal notation. Exponential notation is a way of displaying a number as a digital number multiplied by a power of 10. In the number 5e3, for example, 5 is the digital number and 3 is the power to which 10 is taken. Interpret 5e3 as “5 times the quantity 10 taken to the power of 3,” which equals 5,000 in decimal notation. Likewise, interpret 5e-3 as “5 times the quantity 10 taken to the power of -3,” which equals 0.005 in decimal notation. Interpret 5.2e8 as “5.2 times 10 taken to the power of 8,” or 520,000,000.

**ALOHA gave me an outdoor concentration estimate that’s greater than 1 million parts per million—how can that be?**

You have asked for a concentration estimate for a point very close to the source. ALOHA “knows” that concentrations of a pollutant are extremely high right at the point of release and drop off as you move downwind. It uses equations to approximate what happens in reality. Modelers call ALOHA a “far-field” model because these equations much more accurately predict events at distances of more than a few yards from the source than very near the source. In fact, according to these equations concentration is infinite at the point of release.

**I want to modify a chemical, but I can't change some properties—they appear grey.**

These properties are estimated by ALOHA from other information in its chemical library. To use different property values, add a new chemical (use a name such as "CHLORINE-2"), then enter new property values.

**I am trying to model the release of gas from a gas pipeline, but ALOHA says the pipe is too short. It tells me that the length must be at least 200 times the diameter of the pipe. What should I do?**

If the pipe is too short relative to its diameter, and its diameter is greater than about 8 inches (20 centimeters), use the Tank option instead, selecting the configuration of a horizontal tank. If the pipe is less than 1 meter long and connected to a tank, you also can use the Tank option (in this case, select **Short pipe/valve** as the type of leak). Either of these methods should produce a conservative threat estimate.

**I am using a SAM with ALOHA. I have set the SAM options using the Atmospheric menu, but the Source menu is not available—I can't set my source.**

Either the SAM has not yet been collecting data for 5 minutes, or ALOHA has not received valid data. Before ALOHA can estimate atmospheric stability, it must have received data from the SAM for at least 5 minutes. Check the Text Summary window for a message alerting you that either the SAM has not been transmitting for 5 minutes, or the transmitted data are not valid.

**ALOHA tells me that the input value I just entered is not within allowable limits.**

ALOHA will accept a numeric input value (that is, a value such as puddle area or tank hole diameter that you enter as a number) only if it is within a specified range. These restrictions help to prevent you from inadvertently entering an unrealistic input value. If you enter a value outside of the allowable range, ALOHA will warn you and tell you what the limits are. You must modify your value before ALOHA will continue. Check ALOHA's on-screen help topics for more information about ALOHA inputs.

**When I changed some atmospheric conditions, ALOHA told me that it is unable to verify the consistency between my new atmospheric data and the source data. Then I had to reset the source.**

ALOHA's Puddle, Tank, and Gas Pipeline source strength calculations are affected by atmospheric conditions. ALOHA recomputes source strength whenever possible after you have modified atmospheric information. In some cases it cannot, so it asks you to reenter information about the source. For example, by increasing air temperature, you may cause a tank to be filled to more than 100 percent of capacity, or a puddle's temperature to increase above its boiling point. In such cases, you must enter new source information to resolve the problem.

**I set up a release scenario in ALOHA, then started MARPLOT, clicked on a location on my map, and chose Set Source Point from the ALOHA menu (in MARPLOT's Sharing menu). But I don't see a threat zone on my map. What's wrong?**

Before ALOHA can place a threat zone on your MARPLOT map, a threat zone plot needs to be displayed in ALOHA. To solve your problem, in ALOHA, choose **Threat Zone** from the **Display** menu, then return to MARPLOT. You should now see the threat zone on your map.

**My computer crashed while I had an ALOHA threat zone plotted on a map in MARPLOT. Now whenever I reopen the map, I see the old threat zone on the map, and I can't delete it; MARPLOT tells me that the ALOHA layer is locked.**

To delete a threat zone remaining on a map after a crash, delete the entire ALOHA layer (open the map again in MARPLOT, choose **Layer List** from MARPLOT's **List** menu, click on the lock icon for the ALOHA layer to unlock the layer, then click **Delete** while the ALOHA layer is highlighted in the layer list). A new ALOHA layer will be added next time you plot a threat zone on the map.

**I'm running MARPLOT with ALOHA while I respond to a spill. I'm also using a SAM station to collect weather data. I've had a threat zone displayed in MARPLOT for the last half hour. I know the wind has shifted direction but the threat zone hasn't changed at all. What's wrong?**

Whenever you bring MARPLOT forward (so that its windows are in front of ALOHA's windows), you'll halt data transmission from the SAM to ALOHA. Bring ALOHA forward to update the weather data and threat zone.

**We have two computers in our office that sometimes give different answers for the same ALOHA scenario.**

Individual computers can come up with different answers when they make the same calculations. In particular, different computers can round off numbers differently as they make their calculations. This can have a visible effect on ALOHA's source and dispersion estimates.

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# Glossary

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## **AEGLs**

Acute Exposure Guideline Levels (AEGLs) are Toxic Levels of Concern (LOCs) that you can use in ALOHA to predict the area where a toxic gas concentration might be high enough to harm people. The AEGLs are under development by the National Research Council's National Advisory Committee on AEGLs. AEGLs take into account sensitive individuals and are meant to protect nearly all people. As of October 2005, the final AEGL values for more than 20 chemicals have been released, interim AEGL values for more than 60 additional chemicals have also been established, and proposed AEGL values for more chemicals are under review. The committee's objective is to define AEGLs for the 300+ extremely hazardous substances listed in Title III of the Superfund Amendment and Reauthorization Act (the U.S. Environmental Protection Agency offers an online list of these substances). AEGL Web site: <http://www.epa.gov/oppt/aegl/index.htm>.

## **Aerosol**

Fine liquid droplets (or solid particles) suspended in a gas.

## **Air dispersion model**

A computer model that predicts the movement and dispersion of a gas in the atmosphere.

## **Air exchange rate**

The number of times per unit time that the volume of air within a building is completely replaced by new outdoor air when doors and windows are closed. Usually expressed as number of air changes per hour.

## **ALOHA**

ALOHA stands for Areal Locations of Hazardous Atmospheres. (ALOHA is a registered trademark of the U.S. government).

**Ambient saturation concentration**

The maximum concentration of vapor that could be attained in the air in a closed space above a liquid at ambient temperature and pressure. If a chemical has a high ambient saturation concentration, it has a strong ability to displace air, and the concentration of the chemical's vapor in the air above the liquid will be high. If it has a low ambient saturation concentration, the vapor concentration will be low. This property changes with temperature—a liquid at a higher temperature will have a higher ambient saturation concentration. A chemical that is a gas at ambient temperature and pressure has an ambient saturation concentration of 100% (1,000,000 ppm).

**Anhydrous**

Without water. A chemical shipped or stored without water, rather than in solution, is in anhydrous form (anhydrous ammonia is a common example).

**Atmospheric stability**

A measure of the tendency of air to move upward or downward within the atmosphere, generating turbulence. The atmosphere may be more or less turbulent at any given time, depending on the amount of incoming solar radiation as well as other factors. Meteorologists have defined six atmospheric stability classes, from A to F, each representing a different degree of turbulence in the atmosphere. When moderate to strong incoming solar radiation heats air near the ground, causing it to rise and generating large eddies, the atmosphere is considered unstable. Unstable conditions are associated with atmospheric stability classes A and B (air has a strong tendency to move up or down, and the atmosphere is more turbulent). When solar radiation is relatively weak or absent, air near the surface has a reduced tendency to rise and less turbulence develops. In this case, the atmosphere is considered stable, the wind is weak, and the stability class would be E or F. Stability classes D and C represent conditions of more neutral stability (moderately turbulent). Neutral conditions are associated with relatively strong wind speeds and moderate solar radiation.

**BLEVE**

BLEVE stands for Boiling Liquid Expanding Vapor Explosion. BLEVEs typically occur in closed storage tanks that contain a liquefied gas, usually a gas that has been liquefied under pressure. Although both flammable and nonflammable liquefied gases may be involved in a BLEVE, ALOHA only models flammable liquid BLEVEs.

A common BLEVE scenario happens when a container of liquefied gas is heated by fire, increasing the pressure within the container until the tank ruptures and fails. When the container fails, the chemical is released in an explosion. If the chemical is above its boiling point when the container fails, some or all of the liquid will flash-boil—that is, instantaneously become a gas. If the chemical is flammable, a burning gas cloud called a fireball may occur if a significant amount of the chemical flash-boils. ALOHA assumes that any liquid not consumed in the fireball will form a pool fire. Potential BLEVE hazards include thermal radiation, overpressure, hazardous fragments, smoke, and toxic byproducts from the fire.

**Boiling point**

The maximum temperature at which a substance's liquid phase can exist in equilibrium with its vapor phase. Above the boiling point a liquid vaporizes completely. The boiling point depends on a chemical's composition and the applied pressure. As pressure increases, the boiling point of a substance also increases. The boiling point is also the temperature at which the vapor pressure of a liquid is equal to the applied atmospheric pressure. The "normal boiling point" is the temperature at which a liquid under 1 atmosphere of pressure boils. The "ambient boiling point" is the temperature at which the chemical boils at the ambient pressure.

**Burn Duration**

The length of time that a flammable substance burns. ALOHA limits burn duration to 1 hour.

**Cloud cover**

The fraction of the sky that is obscured by clouds. ALOHA uses a scale in which cloud cover is measured in tenths (for example, when half the sky is covered by clouds, the cloud cover is 5 tenths).

<b>Concentration</b>	The amount of a chemical present in a given weight or volume of air. In ALOHA, concentration of a gas in air is expressed in units such as parts per million (by volume) or milligrams per cubic meter.
<b>Concentration patchiness</b>	Distribution of a pollutant gas as patches of high and low concentration. Especially near the source of a release, wind eddies push a pollutant cloud unpredictably about, causing gas concentrations at any moment to be high in one location and low in another. ALOHA does not account for concentration patchiness near the point of a release.
<b>Congestion</b>	A concept used to quantify the way small structures within the vapor cloud affect the severity of a vapor cloud explosion. Congestion refers to the density of obstacles that generate turbulence. Obstacles of this nature are generally small, like a shrub, and do not impede the flame front. Larger objects, like a building, can impede the flame front, so they should not be considered obstacles for the purposes of congestion. Greater turbulence allows the flame front to accelerate, thereby generating a more powerful blast wave (i.e., greater overpressure). ALOHA uses two congestion levels: congested and uncongested.
<b>Conservative</b>	An estimate that is more likely to result in threat zone and hazard estimates that are too large rather than too small. Selecting conservative choices for weather conditions (low wind speed and a stable atmosphere), source strength (larger puddle area or higher release rate), or LOC (a small LOC) results in a larger threat zone.
<b>Continuous source</b>	A source that releases gas into the atmosphere at a constant or near-constant rate for an extended period of time.
<b>Crosswind</b>	Perpendicular to the wind.
<b>Cryogenic</b>	Relating to processing or storing substances at very low temperatures. For purposes of ALOHA, the use and storage of gases liquefied by refrigeration.

<b>Daylight savings time</b>	At most U.S. locations, daylight savings time is put into effect each spring when local standard time is advanced by 1 hour (the time is moved back 1 hour in the fall to become standard time again). When you select a U.S. location, ALOHA automatically switches between standard to daylight savings time for you when necessary, depending on the date that you enter. You must manually make this switch for locations outside the U.S.
<b>Deflagration explosion</b>	An explosion where the flame front travels relatively slowly (subsonic speeds), as compared to a supersonic detonation.
<b>Density</b>	The ratio of the mass (weight) of a substance to the volume it occupies. For example, if 1 cubic foot of a substance weighs 10 pounds, its density is 10 pounds per cubic foot.
<b>Detonation explosion</b>	An explosion where the flame front travels at supersonic speeds as a shock wave. Explosions of this nature are often triggered by a high-power explosive device. Typically, detonation explosions are significantly more damaging than deflagration explosions.
<b>DIPPR data</b>	Values for physical properties compiled by the Department of Chemical Engineering of Brigham Young University for the Design Institute for Physical Property Data (DIPPR) of the American Institute of Chemical Engineers. These values are included in ALOHA's chemical library for more than half of the chemicals in the library. DIPPR Web site: <a href="http://dippr.byu.edu">http://dippr.byu.edu</a> .
<b>Direct source</b>	Choose this source option when you know, or can estimate, either the amount of pollutant gas entering the atmosphere or its rate of entry (i.e., evaporation rate).
<b>Dispersion</b>	For ALOHA's purposes, the process by which a cloud of pollutant gas spreads out into the atmosphere, mixing with the air and eventually becoming diluted to below hazardous levels.

**Eddies**

Parcels of air of various sizes that leave their normal position within an otherwise orderly, smooth flow. For example, air that encounters an obstacle must go over or around it. This change in the direction of air flow often causes “swirls” of air, or eddies, to tumble off the back of the obstacle. Impediments to airflow ranging from simple friction (grass) to larger obstacles (buildings) can cause eddies in a variety of sizes to form.

**ERPGs**

The Emergency Response Planning Guidelines (ERPGs) are Toxic Levels of Concern (LOCs) that you can use in ALOHA to predict the area where a toxic gas concentration might be high enough to harm people. The ERPGs were developed by the ERPG committee of the American Industrial Hygiene Association. The ERPGs were developed as planning guidelines, to anticipate human adverse health effects caused by exposure to toxic chemicals. The ERPGs are three-tiered guidelines with one common denominator: a 1-hour contact duration. Each guideline identifies the substance, its chemical and structural properties, animal toxicology data, human experience, existing exposure guidelines, the rationale behind the selected value, and a list of references. ERPG Web site: <http://www.aiha.org>.

**Exponential notation**

ALOHA displays its results in exponential notation whenever numbers are too large to display in decimal notation. Exponential notation is a way of displaying a number as a digital number multiplied by a power of 10. In the number  $5e3$ , for example, 5 is the digital number and 3 is the power to which 10 is taken. Interpret  $5e3$  as “5 times the quantity 10 taken to the power of 3,” which equals 5,000 in decimal notation.

**Fireball**

A burning and expanding gas cloud formed during a BLEVE of a flammable chemical. The fireball is made up of both the chemical that flash-boils when the tank fails and the chemical that sprays out as an aerosol during the explosion. The primary hazard associated with a fireball is thermal radiation.

**Flammable**

Easy to ignite and burns readily. The U.S. Department of Transportation defines flammable liquids as those liquids that have a flash point below 100°F (37.8°C).

<b>Flammable area</b>	The part of a flammable vapor cloud where the concentration is in the flammable range, between the Lower and Upper Explosive Limits (LEL and UEL). The flammable area will burn rapidly when ignited because that portion of the cloud is already pre-mixed to the right mixture of fuel and air for burning to occur. Following the rapid burning, the part of the cloud where the fuel-air concentration is above the UEL may continue to slowly burn as air mixes with the cloud.
<b>Flash fire</b>	When a flammable vapor cloud encounters an ignition source, the cloud can catch fire and burn rapidly in what is called a flash fire. Possible hazards associated with a flash fire include thermal radiation, smoke, and toxic byproducts from the fire. ALOHA will predict the flammable area of the vapor cloud—that is, the area where a flash fire could occur at some time after the release.
<b>Flash point</b>	Minimum temperature at which a liquid's vapor pressure is sufficiently high to produce a flammable mixture with air above the liquid.
<b>Flash-boil</b>	The sudden vaporization of a liquid. This occurs most often when a chemical is a gas at standard temperature and pressure, but is stored as a liquid under pressure. If the storage container ruptures, the sudden reduction in pressure can cause the liquid to boil violently (“flash-boil”) and the tank contents to foam up, filling the tank with a two-phase mixture of gas and liquid.
<b>Footprint</b>	See Threat zone.
<b>Freezing point</b>	Also, melting point. The temperature at which the solid and liquid phases of a substance exist in equilibrium. The freezing point depends on the chemical composition and the applied pressure. The “normal freezing point” is defined at a pressure of 1 atmosphere. For example, the normal freezing point of water is 0°C (32°F).

<b>Fuel reactivity</b>	A characteristic of a chemical that rates the tendency of the flame front to accelerate when a vapor cloud burns. The reactivity ratings are related to the speed of the flame front when there is no turbulence (laminar burning velocities).
<b>Fumes</b>	Dense, smoke-like vapors given off by fuming materials such as very reactive liquids, gases, or molten metals (for example, concentrated hydrochloric acid or sulfur monochloride). Fuming corrosive materials produce dense, choking, smoke-like clouds on contact with the moisture in air. Some liquefied gases that react with water when they evaporate (such as anhydrous hydrogen fluoride and anhydrous hydrogen chloride) also produce fumes. Fumes from hot or molten metals may not have a dense, smoke-like appearance but are hazardous, usually by inhalation.
<b>Gas(es)</b>	Evenly dispersed molecules of a material at a temperature above its boiling point. A gas, unlike solids and liquids, does not have an independent shape or volume (a gas expands to fill available space, and the volume taken up by a gas depends on the pressure exerted on it). Examples of gases include oxygen, air (a mixture of nitrogen, oxygen, and trace amounts of other gases), chlorine, and carbon dioxide.
<b>Gaussian</b>	A Gaussian curve is a bell-shaped, or “normal,” probability curve (named after a famous mathematician). ALOHA uses a Gaussian distribution to describe the movement and spreading of a gas that is neutrally buoyant (about as dense as air).
<b>GMT</b>	Greenwich Mean Time or Coordinated Universal Time. The reference time along the prime meridian (0° longitude), which passes through Greenwich, England.



<b>Ground roughness</b>	The roughness of the ground (over which a pollutant cloud is moving). Degree of ground roughness depends on the size and number of roughness elements, which can range in size from blades of grass to buildings. Ground roughness generates air turbulence, which acts to mix air into the pollutant cloud and dilute the pollutant gas. When all else is equal, a threat zone will be smaller when you choose a larger ground roughness value.
<b>Ground temperature</b>	The temperature of the ground beneath an evaporating puddle. ALOHA uses your value for ground temperature to estimate the amount of heat that is transferred from the ground to an evaporating puddle.
<b>Ground type</b>	The physical composition of the ground beneath a puddle. The ground type is especially important when a refrigerated liquid spills to form a boiling puddle. In such cases, often more of the heat required for puddle evaporation is supplied by the ground rather than the atmosphere.
<b>Hazardous fragments</b>	One of the major hazards associated with any explosion. Hazardous fragments are flying debris propelled by the explosion's pressure wave. Hazardous fragments come from two primary sources: container fragments and debris from the surrounding area.
<b>Heat of combustion</b>	Energy released as heat when a chemical undergoes complete combustion with oxygen—that is, burns completely. The heat of combustion is usually determined experimentally. The units are expressed as energy/amount of fuel (e.g., J/kg or BTU/lb).
<b>Heavy gas</b>	A gas cloud that is denser than the air around it. There are several reasons why a gas forms a heavy gas cloud, or behaves like a heavy gas: 1) because its molecular weight is greater than that of air (about 29 kilograms/kilomole), 2) because it is stored cryogenically (refrigerated), or 3) because aerosols form in sufficient quantity during a release to cause the mixture to behave like a heavy gas.

<b>IDLH</b>	The Immediately Dangerous to Life or Health (IDLH) level is a limit originally established for selecting respirators for use in workplaces by the National Institute for Occupational Safety and Health (NIOSH). A chemical's IDLH is an estimate of the maximum concentration in the air to which a healthy worker could be exposed without suffering permanent or escape-impairing health effects.
<b>Infinite tank source</b>	A case in which a gas pipeline is connected to a reservoir that is so large that gas escapes from the broken end of the pipeline at a constant rate for an indefinite period of time.
<b>Instantaneous source</b>	A very short-term release. ALOHA assumes that an instantaneous release lasts 1 minute.
<b>Inversion</b>	<p>An atmospheric condition in which an unstable layer of air near the ground lies beneath a very stable layer of air above. The height of the abrupt change of atmospheric stability is called the inversion height. An inversion can trap pollutant gases below the inversion height. This may cause ground-level concentrations of a pollutant to reach higher levels than would otherwise be expected.</p> <p>The type of inversion of concern for dispersion modeling is a low-level inversion that could trap a pollutant cloud near the ground. Sea smoke or low ground fog are good indicators of the presence of this type of inversion. A low-level inversion is different from the inversion that causes smog. That type of inversion is typically thousands of feet above the ground—much too high to affect a dispersing gas cloud.</p>
<b>Jet fire</b>	A jet fire, also referred to as a flame jet, occurs when a flammable chemical is rapidly released from an opening in a container and immediately catches on fire—much like the flame from a blowtorch. Thermal radiation is the primary hazard associated with a jet fire. Other potential jet fire hazards include smoke, toxic byproducts from the fire, and secondary fires and explosions in the surrounding area.

**Level of Concern (LOC)**

A threshold value of a hazard (toxicity, flammability, thermal radiation, or overpressure); the LOC is usually the value above which a threat to people or property may exist. For each LOC you choose, ALOHA estimates a threat zone where the hazard is predicted to exceed that LOC at some time after a release begins.

**Liquefied gas**

A gas that has been liquefied by applying a high pressure or by cooling (refrigerating) it below its boiling point. Chemicals that are stored as liquefied gases are gases at ambient pressure and/or temperature.

**Lower Explosive Limit (LEL)**

The Lower Explosive Limit (LEL), also called the Lower Flammability Limit, is the minimum concentration of fuel in the air needed for a fire or an explosion to occur if an ignition source is present. If the concentration is below the LEL, there is not enough fuel in the air to sustain a fire or an explosion—it is too lean. The LEL is determined experimentally using standard temperature and pressure settings. Additionally, if the fuel concentration in the air exceeds the Upper Explosive Limit (UEL), then a fire (or an explosion) cannot occur.

**Mass**

Mass is a physical property related to weight. Mass is a measure of the amount of a substance that occupies a given space. While the weight of a given amount of a substance is a measure of the force by which it is attracted by gravity (and is less on the moon than on the earth), the substance's mass is independent of gravity.

**Maximum Average Sustained Release Rate and Maximum Burn Rate**

ALOHA computes release rate from a puddle, tank, or gas pipeline as a series of hundreds of brief timesteps. Each timestep represents a rate of release that is maintained for a particular amount of time (timesteps are short if release rate is changing rapidly, and longer if release rate is nearly constant).

For releases into the atmosphere, ALOHA averages this series of many release rates into between one and five release rates that are each for a time period of at least 1 minute. For burn rates, ALOHA averages over timesteps lasting 20 seconds. The Maximum Average Sustained Release Rate (or the Maximum Burn Rate, if applicable) is the highest of these averaged release rates. It is represented by the tallest timestep on the Source Strength graph.

<b>Mixing</b>	The process by which air is mixed into a pollutant gas cloud. This includes both mechanical (induced by the wind passing over rough ground) and thermal (induced by surface heating) mixing.
<b>Mole</b>	Amount of a substance containing $6.02 \times 10^{23}$ molecules. The molecular weight of a chemical is the mass of 1 mole of that chemical.
<b>Molecular weight</b>	The sum of the atomic weights of all the atoms in the molecule (the weight of one molecule of the chemical).
<b>Neutrally buoyant gas</b>	A gas that is about as dense as air, and neither positively nor negatively buoyant (neither rises nor sinks in air).
<b>Open Country</b>	An area of low ground roughness, such as a parking lot or open field.
<b>Open Water</b>	A body of water that is large relative to the size of the pollutant cloud that is travelling over it, such as oceans or large lakes. Except when the wind speed is very high, Open Water is the lowest ground roughness category in ALOHA.
<b>Overpressure</b>	Overpressure, also called a blast wave, refers to the sudden onset of a pressure wave after an explosion. This pressure wave is caused by the energy released in the initial explosion—the bigger the initial explosion, the more damaging the pressure wave.
<b>Partial pressure</b>	At equilibrium, molecules move from the liquid to the gas phase at the same rate as they return to the liquid from the gas phase. In liquids that are mixtures of chemicals, each component vaporizes (evaporates) at its own characteristic rate. The partial pressure of a chemical in a mixture is a measure of the concentration of that chemical's gas-phase molecules in the air directly in contact with the liquid. In most actual cases equilibrium is not reached so the partial pressure represents the limiting value for chemical concentration in the air.

<b>Particulates</b>	Solid particles so small that they can disperse in the air like gases (however, unlike gases, particulates eventually “rainout,” or fall to the ground). ALOHA does not model particulate dispersion.
<b>Parts per billion (ppb)</b>	Units of gas or vapor concentration in air: parts of gas per billion parts of air. ALOHA uses parts per million (ppm). (1 ppm = 1 ppb x 1,000)
<b>Parts per million (ppm)</b>	Units of gas or vapor concentration in air: parts of gas per million parts of air. In ALOHA, ppm is by volume, not by weight.
<b>Plume</b>	A cloud of pollutant gas dispersing from a continuous source. A typical plume is a long, cigar-shaped gas cloud.
<b>Plume rise</b>	The upward transport of a gas plume (such as smokestack gases, which rise because they have been heated). ALOHA does not account for plume rise.
<b>Pool fire</b>	<p>A pool fire occurs when a flammable liquid forms a puddle on the ground and catches on fire. ALOHA only models pool fires on land; it does not model pool fires on water.</p> <p>Thermal radiation is the primary hazard associated with a pool fire. Other potential pool fire hazards include smoke, toxic byproducts from the fire, and secondary fires and explosions in the surrounding area.</p>
<b>Relative humidity</b>	The ratio of the amount of water vapor that the air contains to the maximum amount of water vapor that it could hold at the ambient temperature and pressure. Relative humidity is expressed as a percentage. When relative humidity is 50%, the air contains one-half as much water vapor as it could potentially hold.
<b>Release duration</b>	The period of time over which a release occurs. ALOHA limits release duration to 1 hour.

<b>Roughness length</b>	Also, $Z_0$ . A numerical measure of ground roughness.
<b>Running average</b>	An average taken in consecutive, overlapping segments (e.g., the average of the first five values, then the average of the second through sixth values, then the average of the third through seventh values, etc.).
<b>SAM</b>	Station for Atmospheric Measurements. A portable meteorological measurement station that can transmit weather data to ALOHA through a computer's serial port.
<b>Save file</b>	A file containing information about a release scenario that you have entered into ALOHA. You can reopen and modify a save file in ALOHA. Choose Save from the File menu to create a save file.
<b>Serial port</b>	A data interface on a computer through which peripheral devices, such as a SAM, scanner, printer, or digitizing tablet, can be connected. ALOHA can receive weather data from a SAM through a serial port.
<b>Sigma theta</b>	The standard deviation of the wind direction. A SAM configured for use with ALOHA measures changes in wind direction, then transmits an estimate of sigma theta. ALOHA uses this value for sigma theta and the wind speed to estimate stability class.
<b>Smoke</b>	A mixture of gases, suspended solid particles, and vapors resulting from combustion.
<b>Solubility</b>	A measure of a chemical's ability to dissolve in water. If a chemical is highly soluble, it will dissolve easily into water.

<b>Solution strength</b>	Mixtures of chemicals in which the components are interspersed uniformly at the molecular level are called solutions. The strength of a solution in ALOHA is defined as the mass of the volatile hazardous component divided by the mass of the solution. For example, the strength of an oleum solution is defined as the mass of free sulfur trioxide divided by the combined mass of the free sulfur trioxide and sulfuric acid.
<b>Solutions</b>	Mixtures of chemicals in which the components are interspersed uniformly at the molecular level. ALOHA's chemical library includes a short list of solutions. Most are solutions of an anhydrous acid and water (e.g., hydrogen fluoride and water). In all cases, only one component of the solution is both toxic and volatile enough to pose an air hazard. For example, in hydrofluoric acid (a solution of hydrogen fluoride and water) it is the hydrogen fluoride that is the air hazard.
<b>Source</b>	The vessel or pool releasing a hazardous chemical into the atmosphere.
<b>Source height</b>	The distance above the ground at which a chemical is being released.
<b>Source Strength</b>	Either the rate the chemical enters the atmosphere or the burn rate, depending on the scenario. A chemical may escape very quickly (so that source strength is high), as when a pressurized container is ruptured, or more slowly over a longer period of time (so that source strength is low), as when a puddle evaporates.
<b>Stability class</b>	See Atmospheric stability.
<b>Stable</b>	The atmosphere is stable when little air turbulence exists, so that there is little tendency for air to be mixed into a dispersing pollutant cloud.

<b>Standard deviation</b>	A measure of the degree to which individual values deviate from an average value. Computed as the square root of the sum of the squared deviations divided by the number of measurements.
<b>STP</b>	Standard Temperature and Pressure. Physical properties, such as boiling point, are often expressed at standard temperature (0°C) and standard pressure (1 atmosphere).
<b>Street canyon</b>	A street bordered along both sides by high-rise buildings that block air movement, so that the wind and any dispersing pollutant cloud are channeled down the street.
<b>Sublimation</b>	A frozen substance sublimates when it passes directly into the gas phase without first becoming liquid.
<b>TEELs</b>	Temporary Emergency Exposure Limits (TEELs) are temporary Toxic Levels of Concern (LOCs) similar to ERPGs, and defined by the U.S. Department of Energy for use when ERPGs aren't available. Unlike AEGLs and ERPGs, TEELs are not peer-reviewed, and are intended as temporary guidance. AEGLs, ERPGs, and TEELs do not incorporate safety factors. Rather, they are designed to represent the predicted response of members of the general public to different concentrations of a chemical during an incident. TEEL Web site: <a href="http://tis-hq.eh.doe.gov/web/Chem_Safety/teel.html">http://tis-hq.eh.doe.gov/web/Chem_Safety/teel.html</a> .
<b>Terrain steering</b>	The way in which land features, such as hills and valleys, modify the speed and direction of air flow.
<b>Thermal radiation</b>	Heat released during a fire and explosion that may pose a hazard to people and structures. The effects people experience will depend on both the level of thermal radiation and the length of time they are exposed to it.



<b>Threat at Point</b>	ALOHA can model one or more of the following hazards: toxicity, flammability, thermal radiation, or overpressure. Once you have displayed a hazard on a threat zone plot, you can use the Threat at Point option to obtain specific information about the hazards at points of interest (such as schools and hospitals) in and around the threat zones.
<b>Threat distance</b>	The downwind distance along the centerline of a chemical cloud, out to the level of concern that you set. ALOHA's threat zone lengths, reported in the Text Summary window, are threat distances.
<b>Threat zone</b>	Area within which the hazard level (toxicity, flammability, thermal radiation, or overpressure) is predicted to exceed your Level of Concern (LOC) at some time after a release begins. You may specify up to three LOCs in ALOHA. If three LOCs are chosen, ALOHA will display the threat zones in red, orange, and yellow, overlaid on a single threat zone plot. By default, the red zone represents the worst hazard.
<b>Time-dependent dispersion</b>	A time-dependent value is something that changes over time. ALOHA's dispersion predictions account for release rates that change over time; in this sense, these predictions are time-dependent. However, ALOHA does not account for changing atmospheric conditions when predicting dispersion: in this sense, its predictions are not time-dependent.
<b>Time-dependent source</b>	A release rate that changes over time. For example, release rate from a pressurized tank declines over time as tank pressure drops.

**Two-phase flow**

Both the liquid and gas phases of a chemical sometimes can escape together from a ruptured tank or pipeline as a two-phase flow. Many substances that are gases under normal pressures and temperatures are stored under high enough pressures to liquefy them. For example, ammonia is a gas at normal pressures and temperatures but is often stored under pressure as a liquid. When a rupture or broken valve causes a sudden pressure loss in a tank of liquefied gas, the liquid boils violently, the tank contents foam up, and the tank fills with a mixture of gas and fine liquid droplets (called aerosol). When such a two-phase mixture escapes from the container, the release rate can be significantly greater than that for a purely gaseous release.

**Unstable**

The atmosphere is unstable when substantial air turbulence exists, so that there is a strong tendency for air to be mixed into a dispersing pollutant cloud.

**Upper Explosive Limit (UEL)**

The Upper Explosive Limit (UEL), also called the Upper Flammability Limit, is the maximum concentration of fuel in the air that can sustain a fire or an explosion if an ignition source is present. If the concentration is above the UEL, there is not enough oxygen to sustain a fire or an explosion—it is too rich (much like an engine that cannot start because it has been flooded with gasoline). The UEL is determined experimentally using standard temperature and pressure settings. Additionally, if the fuel concentration in the air falls below the Lower Explosive Limit (LEL), then a fire (or an explosion) cannot occur.

**Urban or Forest**

An area of relatively high ground roughness, such as residential housing developments, industrial areas or forests.

**Vapor**

The gas produced by the evaporation of a liquid (or sublimation of a solid). For example, the gas produced when liquid water evaporates is water vapor.

<b>Vapor cloud explosion</b>	When a flammable chemical is released into the atmosphere, it forms a vapor cloud that will disperse as it travels downwind. If the cloud encounters an ignition source, the parts of the cloud where the concentration is within the flammable range (between the Lower and Upper Explosive Limits) will burn. The speed at which the flame front moves through the cloud determines whether it is a deflagration or a detonation. In some situations, the cloud will burn so fast that it creates an explosive force (blast wave). Two primary hazards are associated with a vapor cloud explosion: overpressure and hazardous fragments.
<b>Vapor pressure</b>	Vapor pressure is a property of a liquid. At equilibrium, molecules move from the liquid to the gas phase at the same rate as they return to the liquid from the gas phase. The vapor pressure is a measure of the concentration of gas-phase molecules in the air directly in contact with the liquid, at equilibrium. In most actual cases equilibrium is not reached so the vapor pressure represents the limiting value for chemical concentration in the air.
<b>Volatility</b>	The tendency of a liquid (or solid) to form a vapor (evaporate).
<b>Wind direction</b>	The direction from which the wind is blowing.
<b>Wind Rose</b>	For ALOHA's purposes, a diagram displaying recent measurements of average wind speed and direction at a location when a SAM is used.
<b>Z<sub>0</sub></b>	See Roughness length.

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# Index

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## A

accuracy, 5  
advection, 6  
AEGLs, 159  
aerosol  
    definition of, 159  
    heavy gas, 7  
    jet fire, 14  
    Tank source, 128  
air dispersion model, 5  
air exchange rate, 96  
air temperature, 109  
ALOHA  
    basic organization, 1  
    choosing a model, 139  
    duration limits, 120  
    Folder, 23  
    installing, 22  
    limitations of, 18–21  
    menu bar, 3  
    purpose of, 1  
    save files, 91  
    space requirements, 22  
ambient saturation concentration, 100  
anhydrous, 160  
Atmospheric menu item  
    SAM Station, 113–118  
    User Input, 104–112  
atmospheric stability  
    definition of, 160  
    very stable conditions, 18  
atmospheric stability. *See also* stability class  
atmospheric transmissivity, 112  
autoignition temperature, 9

## B

blast force. *See* overpressure  
blast wave. *See* overpressure  
BLEVE  
    explanation of, 15  
    fireball, 15  
    hazardous fragments, 15  
boiling point, 161  
Building Type menu item  
    air exchange rate, 96  
    choice of building, 95  
    surroundings, 96  
Building Type menu item, 95–96  
burning puddle. *See* pool fire  
byproducts, 21

## C

Calculation Options menu item, 139  
CAMEO, 150  
carcinogen, 101  
chemical  
    adding to library, 103  
    deleting from library, 104  
    flammable and toxic, 9  
    library (ChemLib), 98  
    mixtures, 21  
    modifying library, 103  
    properties needed table, 102  
    reactive chemicals, 21, 100  
    selecting a chemical, 99  
    selecting a solution, 99  
CityLib, 92  
cloud cover, 109

concentration  
  average, 20  
  definition of, 162  
  patchiness near source, 20  
  Threat at Point, 146  
Concentration at Point graph, 146  
concentration patchiness, 16, 20  
confidence lines  
  threat zone plot, 143  
  very low wind speeds, 18  
confinement, 17  
congested, 17  
congestion, 17  
conservative, 162  
continuous release, 122  
Coordinated Universal Time, 166  
coordinates, fixed, 145  
coordinates, relative, 145  
Copy menu item, 91  
crosswind, 6  
cryogenic  
  definition of, 162  
  heavy gas, 7  
  Puddle source, 126  
  Tank source, 135

## D

Date & Time menu item, 97  
daylight savings time  
  at non-U.S. locations, 95  
  at U.S. locations, 94  
  definition of, 163  
  multiple time zones, 94  
deflagration explosion, 17  
DEGADIS model, 7  
dense gas dispersion, 7  
density, 163  
detonation explosion, 17  
diffusion, 6

Direct source, 121–123  
  continuous release, 122  
  instantaneous release, 122  
  source height, 123  
  threat zones, 122  
dispersion  
  choice of model, 8  
  dispersion modeling, 5–8  
  Gaussian, 6  
  heavy gas, 7  
  particulates, 21  
  radioactive particles, 21  
  stability class, 110  
  street canyon, 19  
  terrain steering, 19  
Display menu, 140–149  
Display Options menu item, 149  
display units, 149  
double-storied building, 96

## E

eddies, 19, 164  
Edit menu, 91  
elevation, 93  
English units, 149  
ERPGs, 164  
evaporating puddle. *See* puddle evaporation  
Exit menu item, 91  
explosion  
  explanation of, 11  
  hazardous fragments, 13  
  overpressure, 11  
  thermal radiation, 11

## F

File menu, 90–91  
fire  
  explanation of, 9  
  fuel triangle, 9  
  thermal radiation, 10  
  toxic byproducts, 9

fireball, 15  
fires and explosions  
    ALOHA scenarios, 13–17  
    flammable-toxic chemicals, 9  
    introduction to, 8–13  
    sources and scenarios table, 8  
flame jet. *See* jet fire  
flame pockets, 16  
flammability limits, 9  
flammable area  
    explanation of, 16  
    flame pockets, 16  
flammable, 164  
flash fire, 16  
flash point, 9  
flash-boil  
    BLEVE, 15  
    definition of, 165  
    heavy gas, 7  
flying debris. *See* hazardous fragments  
footprint, 2  
freezing point, 165  
fuel reactivity, 166  
fuel triangle, 9  
fugitive emissions, 5  
fumes, 166

## G

Gas Pipeline source, 137–138  
    hole size, 138  
    infinite reservoir, 137  
    pipe diameter, 137  
    pipe length, 137  
    pipe length, troubleshooting, 154  
    pipe pressure, 138  
    pipe roughness, 137  
    pipe temperature, 138  
    Text Summary, 138  
Gaussian  
    definition of, 166  
    dispersion, 6  
GIS, 144

GMT (Greenwich Mean Time), 94, 166  
Greenwich Mean Time (GMT), 94, 166  
ground roughness  
    about, 107  
    choosing a type, 107  
    roughness length, 108  
ground temperature, 127, 136  
ground type, 126, 136

## H

hazardous fragments  
    BLEVE, 15  
    definition of, 167  
    explanation of, 13  
    from overpressure, 11  
heavy gas  
    definition of, 167  
    dispersion, 7  
    inversions, 112  
    properties needed, 102  
Help Index  
    in Windows, 4  
    on a Macintosh, 4  
Help, on-screen, 4  
humidity, 112

## I

IDLH, 168  
ignition sources (common), 9  
ignition time, 141  
ignition type, 142  
indoor pollutant concentration, 96, 146  
infiltration rate, 96  
Installing ALOHA  
    in Windows, 23  
    on a Macintosh, 23  
    previous versions, 22  
    space requirements, 22  
instantaneous release, 122  
inversion, 111

**J**

jet fire, 14

**L**

latitude, 93

Level of Concern (LOC)

    default toxic LOC, 141

    in Text Summary, 101

    overpressure, 12

    thermal radiation, 10

    threat zone, 141

    toxic hierarchy, 101

liquefied gas, 128, 169

Location menu item

    adding a non-U.S. location, 94

    adding a U.S. location, 93

    CityLib, 92

    deleting a location, 95

    modifying a location, 95

    selecting a location, 92

    sun angle, 92

longitude, 93

Lower Explosive Limit (LEL), 9, 16

Lower Flammable Limit (LFL), 16

low-level inversion, 112

**M**

MARPLOT

    menu, 151

    threat zone, 152

    troubleshooting

        SAM, 155

        Set Source Point, 155

        threat zone, 155

    using, 151

Max Average Sustained Release Rate, 121

Max Burn Rate, 121

melting point, 165

Metric units, 149

**N**

near-field patchiness, 20

neutrally buoyant gas, 6, 7

New menu item, 90

**O**

office building (enclosed), 96

open country ground roughness, 107

Open menu item

    planning mode, 90

    response mode, 90

    saved file, 90

open water ground roughness, 107

output units, 149

overpressure

    damage table, 12

    definition of, 170

    explanation of, 11

    Levels of Concern, 12

**P**

partial pressure, 170

particulates, 171

parts per billion (ppb), 171

parts per million (ppm), 171

patchiness (concentration), 20

pipe racks, 17

planning mode, 90

plume rise, 171

plume, 171

pool fire, 14

pressure wave. *See* overpressure

Print menu items, 91

puddle evaporation

    about, 124

    air temperature, 109

    cloud cover, 109

    sun angle, 92

    terrain, 21

Puddle source, 123–127  
  area and volume of, 126  
  evaporating puddle, 124  
  ground temperature, 127  
  ground type, 126  
  initial temperature, 127  
  type of puddle, 124

## Q

Quit menu item, 91

## R

radioactive particles, 21  
rainout, 171  
release rate, 121  
Response Information Data Sheets, 150  
response mode, 90  
RIDS, 150  
roughness element, 107  
roughness length ( $Z_0$ ), 108

## S

### SAM

  choosing a SAM, 113  
  data codes, 113  
  dialog boxes, 115  
  radio frequency, 114  
  serial port, 114  
  sigma theta, 117  
  transmitting data, 113  
  troubleshooting, 154  
  using during an incident, 114, 118  
SAM Options menu  
  about, 115  
  Archive Data menu item, 116  
  Processed Data menu item, 117  
  Raw Data menu item, 117  
SAM Station menu item, 113–118  
Save and Save As menu items, 91

save file  
  definition of, 172  
  opening, 90  
serial port, 114  
SetUp menu, 98–140  
Sharing menu, 150–152  
sheltered surroundings, 96  
shock wave. *See* overpressure  
single-storied building, 96  
SiteData menu, 92–97  
solubility, 172  
solution strength  
  definition of, 173  
  entering, 99  
solutions, 173  
Source  
  about, 119  
  Direct source, 121–123  
  duration limits, 120  
  Gas Pipeline source, 137–138  
  Puddle source, 123–127  
  release rate, 121  
  sources and scenarios table, 119  
  Tank source, 127–136  
source height, 123  
source strength  
  about, 147  
  averaging, 149  
  constant, 148  
  variable, 148  
stability class  
  about, 110  
  overriding ALOHA, 111  
  wind speed table, 111  
Stack Windows menu item, 149  
street canyon, 19, 174  
sublimation rate, 125



**T**

Tank source, 127–136  
BLEVE, 132  
chemical state, 129  
contains gas, 131  
contains liquid, 130  
describing the leak, 134  
fireball, 133  
ground temperature, 136  
ground type, 135  
height of leak, 135  
leaking tank, 132  
liquefied gases, 128  
orientation of, 129  
puddle area, 136  
puddles, 128, 135  
size of, 129  
storage temperature, 130  
type of tank failure, 132  
TEELs, 174  
terrain (effect on puddles), 21  
terrain steering, 19, 174  
Text Summary  
about, 147  
chemical data, 100  
Gas Pipeline source, 138  
notes, 101  
thermal radiation  
burn injury table, 10  
definition of, 174  
Levels of Concern, 10  
transmissivity, 112  
Threat at Point  
about, 144  
fixed coordinates, 145  
MARPLOT, 152  
relative coordinates, 145  
results, 145  
threat distance  
definition of, 175  
example of, 51

threat zone  
colors, 143  
displaying in other applications, 144  
flammable vapor clouds, 140  
interpreting, 144  
Level of Concern, 141  
MARPLOT, 152  
menu item, 140  
plot, 143  
threat zone plot, 143  
Tile Windows menu item, 149  
timestep, 121  
toxic byproducts from fire, 9  
two-phase flow  
definition of, 176  
heavy gas, 7  
Tank source, 128

**U**

uncertainty lines. *See* confidence lines  
uncongested, 17  
unsheltered surroundings, 96  
Upper Explosive Limit (UEL), 9, 16  
Upper Flammable Limit (UFL), 16  
urban or forest ground roughness, 107  
User Input menu item, 104–112

**V**

vapor cloud explosion  
congestion level, 142  
deflagration and detonation, 17  
explanation of, 16  
ignited by detonation, 142  
ignition time, 141  
ignition type, 142  
threat zone, 141  
ventilation systems, 96  
volatility, 9  
volume blockage ratio, 17

## W

### wind

- direction, 106

- eddies, 164

- estimating speed, 105

- measurement height, 106

- one-hour duration, 20

- profile, 106

- stability class, 111

- terrain steering, 19

- very low speeds, 18

Wind Rose menu item, 118

## Z

Zo (roughness length), 108