

CAMEO Refresher Exercise Set: August, 2010

CAMEO and Reactive Chemicals: Transportation Incident

Scenario:

A semi tractor-trailer placarded 1033 has overturned on a local roadway. The pressurized tank is lying on its side and has structural damage. Product is leaking from the tank; best estimate is there is a 1" x 1.5" hole in the tank located about halfway up the tank on the front side. In addition, the relief valve appears to have sustained damage, and it is unclear whether the relief valve is functioning properly. Initial information suggests this is an 8,000 gallon capacity tanker. The wind is from the West at 10 mph.

Choose a location in your community where this incident could occur.

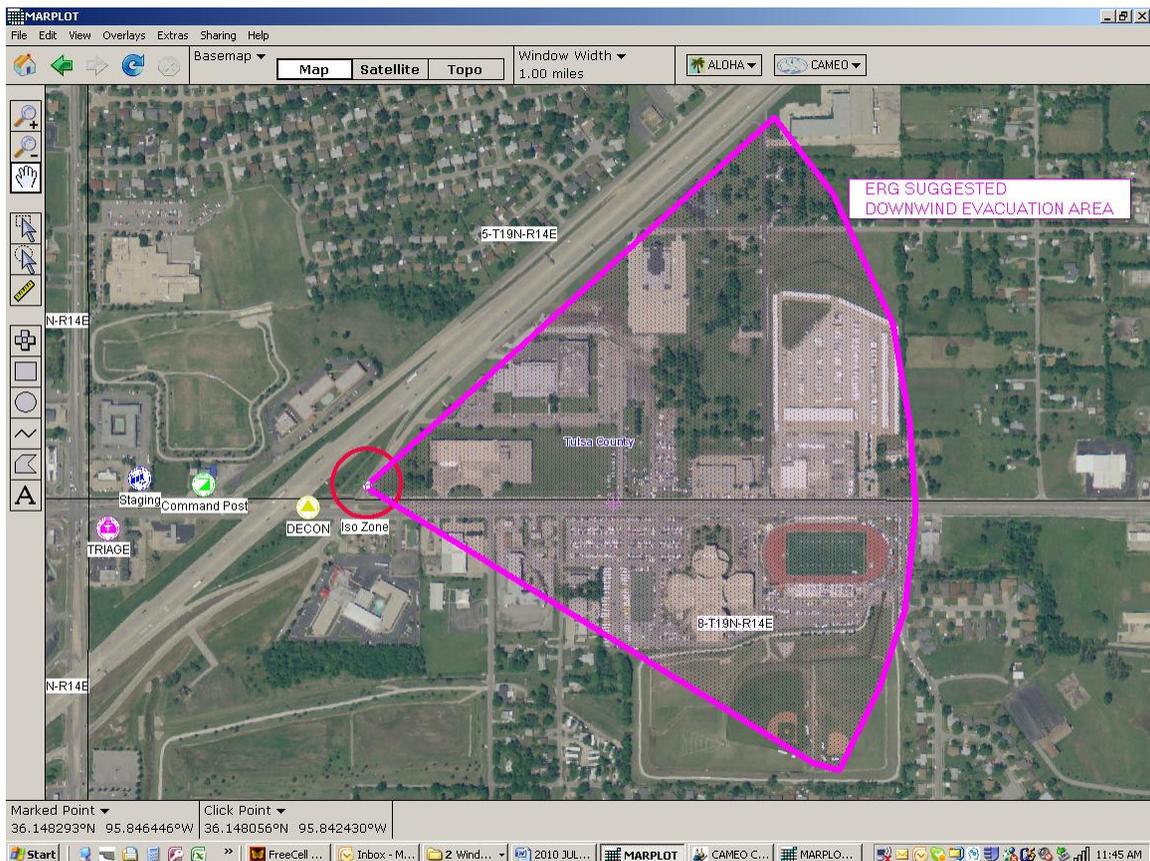
CAMEO Chemicals

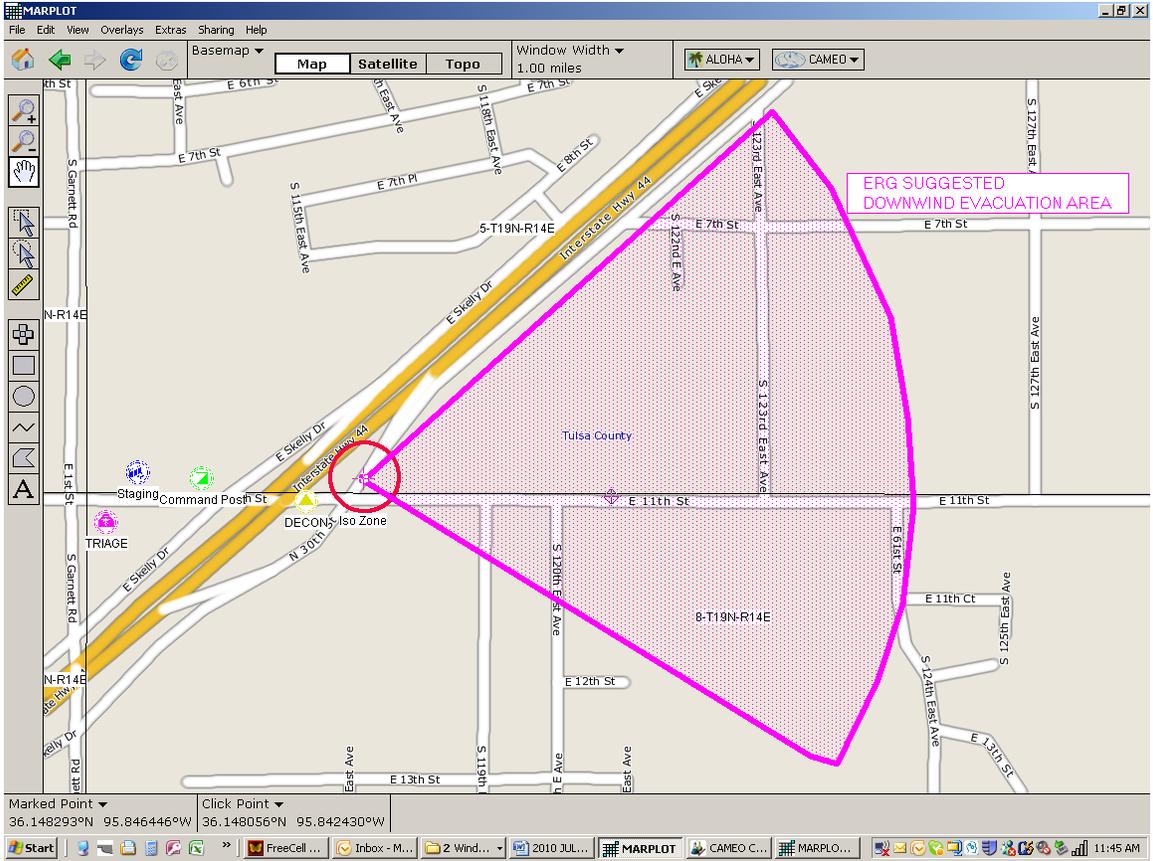
1. Use CAMEO Chemicals to gather information for the various chemicals. (CAMEO Companion pages 31-34)
 - a. What is the product in the tanker?
 - b. Evaluate the hazards of this material. Determine what hazards pose the most immediate threat to the responders and to the community.
 - c. Use the ERG to determine the Immediate Isolation Zone and the Downwind Protection Distance; display both areas on MARPLOT.
 - d. Based on the information, what level of protection would you recommend for entry into the Hot Zone?

2. Use the CAMEO Chemicals "Predict Reactivity" module to evaluate the potential reactive hazards for this incident. (CAMEO Companion pages 34-35)
 - a. Add a listing of materials that could be present at the incident scene to the CAMEO Chemicals "My Chemicals" list (examples: gasoline, diesel, anti-freeze, brake fluid, etc)
 - b. Use the CAMEO Chemicals "Predict Reactivity" module to evaluate the reactive possibilities.
 - c. Is this material Water-Reactive?

MARPLOT

1. Launch MARPLOT
2. Select a location in your area to use as the incident site
3. Navigate to the incident location (CAMEO Companion pages 57-62)
4. Mark the incident location using the “Extras / Marked Point / Mark Click Point” menu (CAMEO Companion pages 65-66)
5. Use the “Circle” drawing tool to display the Immediate Isolation Zone on the map (CAMEO Companion pages 74, 81)
6. Use the “Symbol” drawing tool to display the Command Post, Staging Area, Triage, and Decon points. (CAMEO Companion pages 74-80)
7. Use the “Polygon” drawing tool to display the ERG-suggestion downwind evacuation area
8. Copy and paste a screenshot of the mapped area from MARPLOT to WORD. (CAMEO Companion pages 85)





ALOHA

Use ALOHA to model this incident. Assume the following Weather Conditions:

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 10 miles/hour from w at 3 meters

Ground Roughness: urban or forest Cloud Cover: 5 tenths

Air Temperature: 77° F Stability Class: D

No Inversion Height Relative Humidity: 50%

Lacking additional information concerning the tank parameters and the hole size, responders may be tempted to model this incident using the ALOHA Direct/Instantaneous Source model. In this case, the Direct/Instantaneous Source will overestimate the Threat Zone area.

USING DIRECT/INSTANTANEOUS SOURCE MODEL FOR THE INITIAL RELEASE EVALUATION:

1. Select the appropriate substance from the ALOHA Chemical Library (CAMEO Companion pages 94-95)
2. Enter the Atmospheric conditions given above (CAMEO Companion page 96)
3. Use the ALOHA Direct/Instantaneous Source model (CAMEO Companion pages 99-100)

The ALOHA “Flash Boil” warning message will appear.



4. Read and interpret the ALOHA Help menu for this message. (CAMEO Companion page 102)

Question: which dispersion model (Gaussian or Heavy Gas) is selected by ALOHA for this incident? Why would ALOHA suggest using the Tank Source model for this incident?

5. Select the Display/Threat Zone menu using the dispersion model initially suggested by ALOHA. The “Hazard to Analyze” screen will appear. (CAMEO Companion pages 112-113)

Hazard To Analyze

Scenario:
Flammable chemical escaping directly into atmosphere.
Chemical is NOT on fire.

Choose Hazard to Analyze:

Toxic Area of Vapor Cloud

Flammable Area of Vapor Cloud

Blast Area of Vapor Cloud Explosion

OK Cancel Help

Question: Which hazard do you wish to utilize for this incident? Why? Is it possible to display Threat Zones for all three Hazards?

6. Select “Toxic Area of Vapor Cloud” and select “OK”. The “Toxic Level of Concern” dialog box will appear.

Toxic Level of Concern

Select Toxic Level of Concern:

Red Threat Zone
LOC: TEEL-3: 60000 ppm

Orange Threat Zone
LOC: TEEL-2: 10000 ppm

Yellow Threat Zone
LOC: TEEL-1: 3000 ppm

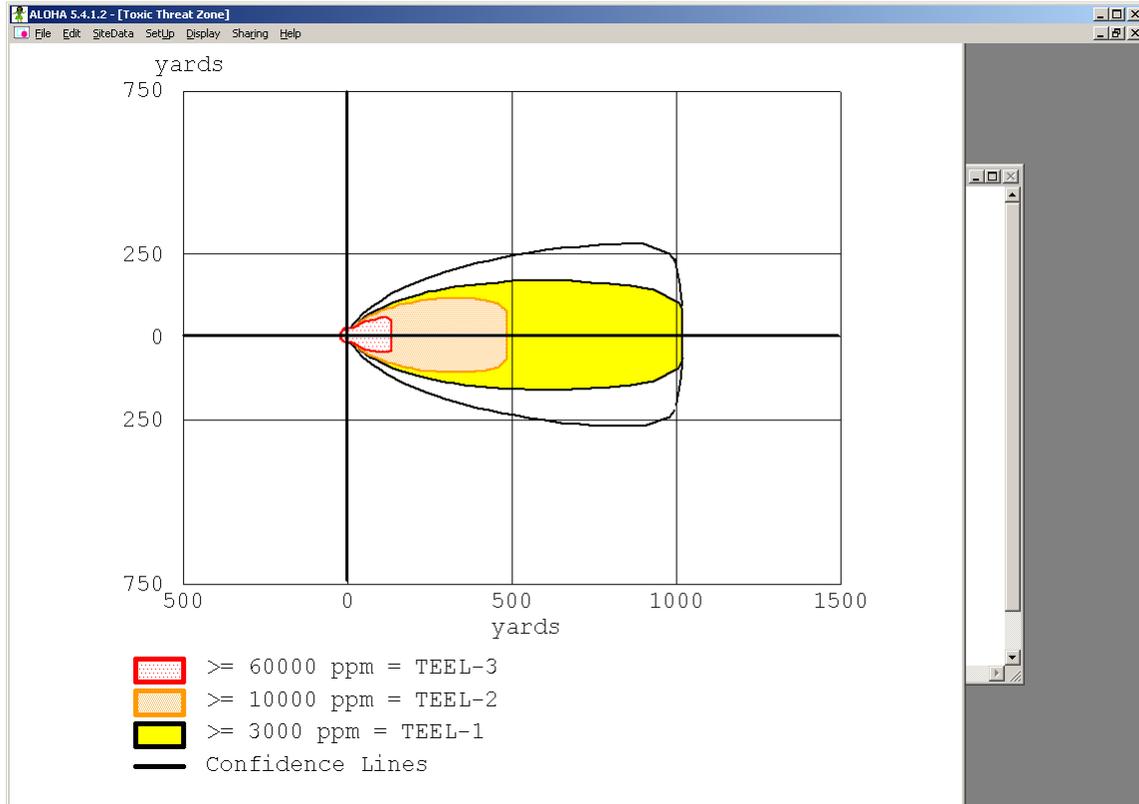
Show confidence lines:

only for longest threat zone
 for each threat zone

OK Cancel Help

Note that the Level of Concern values are all “TEELs” and are expressed in “ppm”. Threat Zones for Flammability, Thermal Radiation, and Overpressure will use different LOC values and different units of measurement.

7. Accept the TEEL values for the Level of Concern; select “OK”



8. Use the Display / Text Summary menu to view the ALOHA Text Summary. Note the information provided in the Source Strength and Threat Zone sections. Particularly note ALOHA has chosen to use the Heavy Gas model for this incident.

SOURCE STRENGTH:

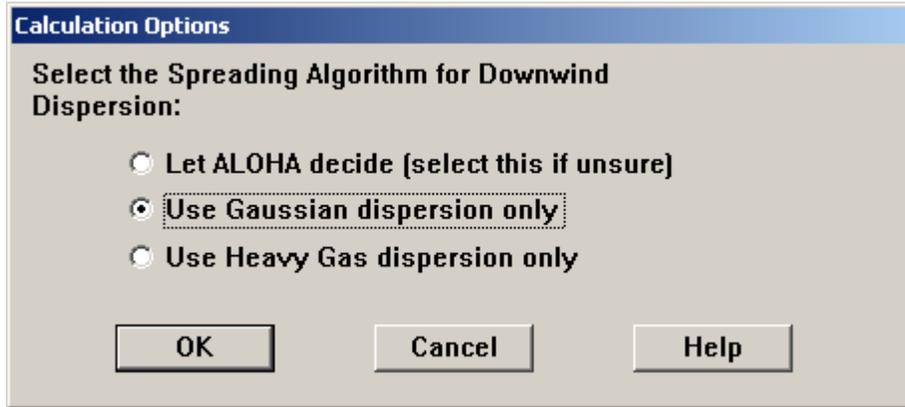
Direct Source: 8000 gallons Source Height: 0
Source State: Liquid
Source Temperature: equal to ambient
Release Duration: 1 minute
Release Rate: 730 pounds/sec
Total Amount Released: 43,793 pounds
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE:

Model Run: Heavy Gas
Red : 134 yards --- (60000 ppm = TEEL-3)
Orange: 488 yards --- (10000 ppm = TEEL-2)
Yellow: 1022 yards --- (3000 ppm = TEEL-1)

COMPARING THE HEAVY GAS AND GAUSSIAN DISPERSION MODELS:

9. Select the Setup / Calculation Options menu; select the Gaussian dispersion model.



10. Compare the Text Summary for the Gaussian model with the Text Summary for the Heavy Gas model. Note that the SOURCE STRENGTH information has not changed, but the THREAT ZONE distances have changed.

SOURCE STRENGTH:

Direct Source: 8000 gallons Source Height: 0
Source State: Liquid
Source Temperature: equal to ambient
Release Duration: 1 minute
Release Rate: 730 pounds/sec
Total Amount Released: 43,793 pounds
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (GAUSSIAN SELECTED)

Model Run: Gaussian
Red : 151 yards --- (60000 ppm = TEEL-3)
Orange: 378 yards --- (10000 ppm = TEEL-2)
Yellow: 697 yards --- (3000 ppm = TEEL-1)

Question: which dispersion model (Gaussian or Heavy Gas) is correct for this incident?

CHANGING FROM THE DIRECT/INSTANTANEOUS SOURCE MODEL TO THE TANK SOURCE MODEL:

11. Select the Setup / Source menu to change from the Direct/Instantaneous source model to the Tank source model.
12. Select "Tank" and enter the following parameters:

Tank Size and Orientation

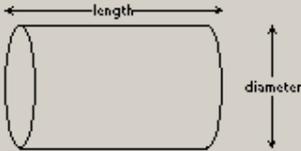
Select tank type and orientation:

Horizontal cylinder

Vertical cylinder

Sphere

Enter two of three values:

 diameter feet meters

length gallons cu feet

volume

Chemical State and Temperature

Enter state of the chemical:

Help

- Tank contains liquid
- Tank contains gas only
- Unknown

Enter the temperature within the tank:

Help

- Chemical stored at ambient temperature
- Chemical stored at degrees F C

OK

Cancel

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



- The liquid volume is:
- gallons
 - cubic feet
 - liters
 - cubic meters

% full by volume

OK

Cancel

Help

Type of Tank Failure

Scenario:

Tank containing a pressurized flammable liquid.

Type of Tank Failure:

- Leaking tank, chemical is not burning as it escapes into the atmosphere
- Leaking tank, chemical is burning as a jet 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

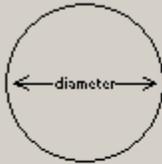
OK

Cancel

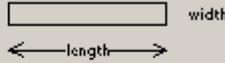
Help

Area and Type of Leak

Select the shape that best represents the shape of the opening through which the pollutant is exiting



Circular opening



Rectangular opening

Opening length:

inches

feet

Opening width:

centimeters

meters

Is leak through a hole or short pipe/valve?

Hole

Short pipe/valve

OK

Cancel

Help

Height of the Tank Opening



The bottom of the leak is:

in

ft

cm

m

above the bottom of the tank

_____ OR _____

% of the way to the top of the tank

OK

Cancel

Help

13. Select the Text Summary and review the Source Strength section.

SOURCE STRENGTH:

Leak from hole in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 6.24 feet Tank Length: 35 feet
Tank Volume: 8000 gallons
Tank contains liquid Internal Temperature: 77° F
Chemical Mass in Tank: 37,342 pounds
Tank is 85% full
Opening Length: 1 inches Opening Width: 1.5 inches
Opening is 0 feet from tank bottom
Release Duration: 20 minutes
Max Average Sustained Release Rate: 2,000 pounds/min
(averaged over a minute or more)
Total Amount Released: 37,342 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

Note: The underlined text above is a summary of data entered by the user; the italicized text is a summary of information calculated by ALOHA based on the user-entered data.

Question: How does the Release Duration vary between the Direct/Instantaneous source model and the Tank model? What is the difference between the Total Amount Released for the two source models?

THREAT ZONE:

Model Run: Heavy Gas
Red : 32 yards --- (60000 ppm = TEEL-3)
Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
Orange: 90 yards --- (10000 ppm = TEEL-2)
Yellow: 189 yards --- (3000 ppm = TEEL-1)

Question: How do the Threat Zone distances vary between the Direct/Instantaneous source model and the Tank model?

CHANGING THE LOCATION OF THE “HOLE”:

14. Select the Setup / Source / Tank menu
15. Advance through the screens without changing any data until you reach the “Height of the Tank Opening” screen. Change to a height of 50% of the way to the top of the Tank.

Height of the Tank Opening

liq.level

The bottom of the leak is:
3.12 in ft cm m
above the bottom of the tank

OR

50 % of the way to the top of the tank

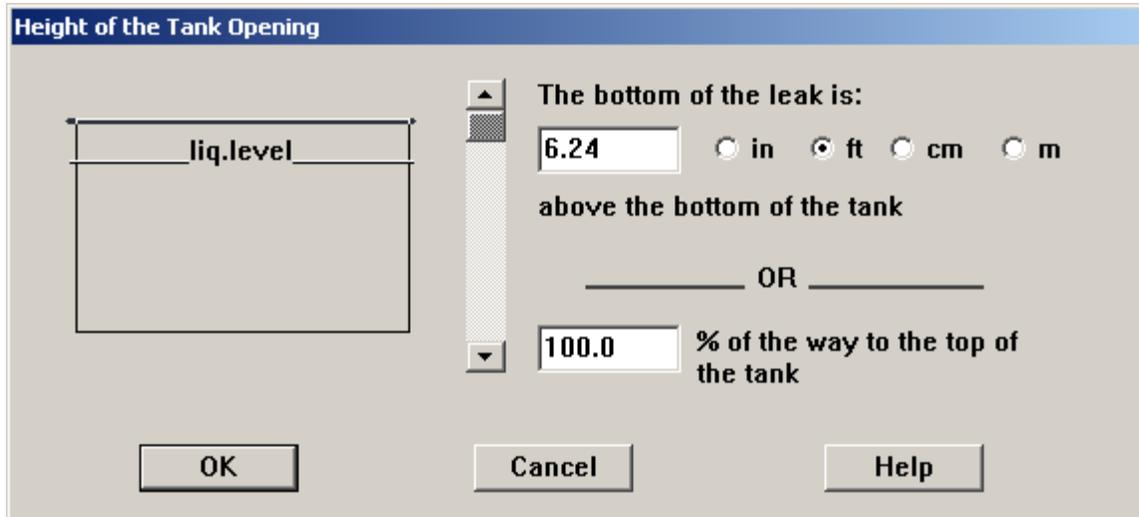
OK Cancel Help

16. Select “OK” and review the Source Strength section of the Text Summary. Note that the Release Duration and the Total Amount Released have changed. ALOHA calculated these changes based on the “hole” location being halfway up the side of the tank rather than on the bottom of the tank.

SOURCE STRENGTH:

Leak from hole in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 6.24 feet Tank Length: 35 feet
Tank Volume: 8000 gallons
Tank contains liquid Internal Temperature: 77° F
Chemical Mass in Tank: 37,342 pounds
Tank is 85% full
Opening Length: 1 inches Opening Width: 1.5 inches
Opening is 3.12 feet from tank bottom
Release Duration: 43 minutes
Max Average Sustained Release Rate: 1,990 pounds/min
(averaged over a minute or more)
Total Amount Released: 35,848 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

17. Select the Setup / Source / Tank menu
18. Advance through the screens without changing any data until you reach the “Height of the Tank Opening” screen. Change to a height of 100% of the way to the top of the Tank.



19. Select “OK” and review the Source Strength section of the Text Summary. Note that the Release Duration and the Total Amount Released have changed. ALOHA calculated these changes based on the “hole” location being on top of the side of the tank rather than on the bottom of the tank.

SOURCE STRENGTH:

Leak from hole in horizontal cylindrical tank
 Flammable chemical escaping from tank (not burning)
 Tank Diameter: 6.24 feet Tank Length: 35 feet
 Tank Volume: 8000 gallons
 Tank contains liquid Internal Temperature: 77° F
 Chemical Mass in Tank: 37,342 pounds
 Tank is 85% full
 Opening Length: 1 inches Opening Width: 1.5 inches
 Opening is 6.24 feet from tank bottom
Release Duration: 45 minutes
Max Average Sustained Release Rate: 1,740 pounds/min
(averaged over a minute or more)
Total Amount Released: 34,355 pounds
 Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

Question: If the “hole” is on the bottom of the tank, the Total Amount Released is 37,342 pounds (all the tank contents). If the “hole” is on the top of the tank, the Total Amount Released is 34,355 pounds. Why? Where is the missing 2,987 pounds?

CHANGING FROM EVALUATING TOXICITY TO FLAMMABILITY and VAPOR CLOUD EXPLOSION:

1. Select the Display / Threat Zone menu; select “Flammable Area of Vapor Cloud”.

Hazard To Analyze

Scenario:
Flammable chemical escaping from tank.
Chemical is NOT on fire.

Choose Hazard to Analyze:

Toxic Area of Vapor Cloud

Flammable Area of Vapor Cloud

Local areas of flame can occur even though the average concentration is below the LEL. ALOHA finds the flammable area by using 60% of the LEL.

Blast Area of Vapor Cloud Explosion

OK Cancel Help

2. Select "OK"; accept the LEL default values; however, notice that ALOHA defaults to 60% and 10% of LEL.

Flammable Level of Concern

Select Flammable Level of Concern:

Red Threat Zone
LOC: 19,800 ppm = 60% LEL = Flame Pockets

Orange Threat Zone
LOC: [none]

Yellow Threat Zone
LOC: 3,300 ppm = 10% LEL

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

OK Cancel Help

3. Select "OK"; compare the Threat Zone section of the Text Summary to the previous Toxic Threat Zone information. Notice the distances are smaller, and the Confidence Lines are smaller. Also notice all the Source Strength values remained constant.

THREAT ZONE: (GAUSSIAN SELECTED)

Threat Modeled: Flammable Area of Vapor Cloud

Model Run: Gaussian

Red : 73 yards --- (19,800 ppm = 60% LEL = Flame Pockets)

Yellow: 181 yards --- (3,300 ppm = 10% LEL)

4. Select the Display / Threat Zone menu; select the “Blast Area of Vapor Cloud Explosion” option.

Hazard To Analyze

Scenario:
Flammable chemical escaping from tank.
Chemical is NOT on fire.

Choose Hazard to Analyze:

Toxic Area of Vapor Cloud

Flammable Area of Vapor Cloud

Blast Area of Vapor Cloud Explosion

OK Cancel Help

5. Select “unknown”, “ignited by spark or flame” and “congested” from the Vapor Cloud Explosion parameters screen

Vapor Cloud Explosion Parameters

Time of vapor cloud ignition: Help

unknown (show composite threat zone from all possible ignition times)

known, ignition time is :

Type of vapor cloud ignition: Help

ignited by spark or flame

ignited by detonation

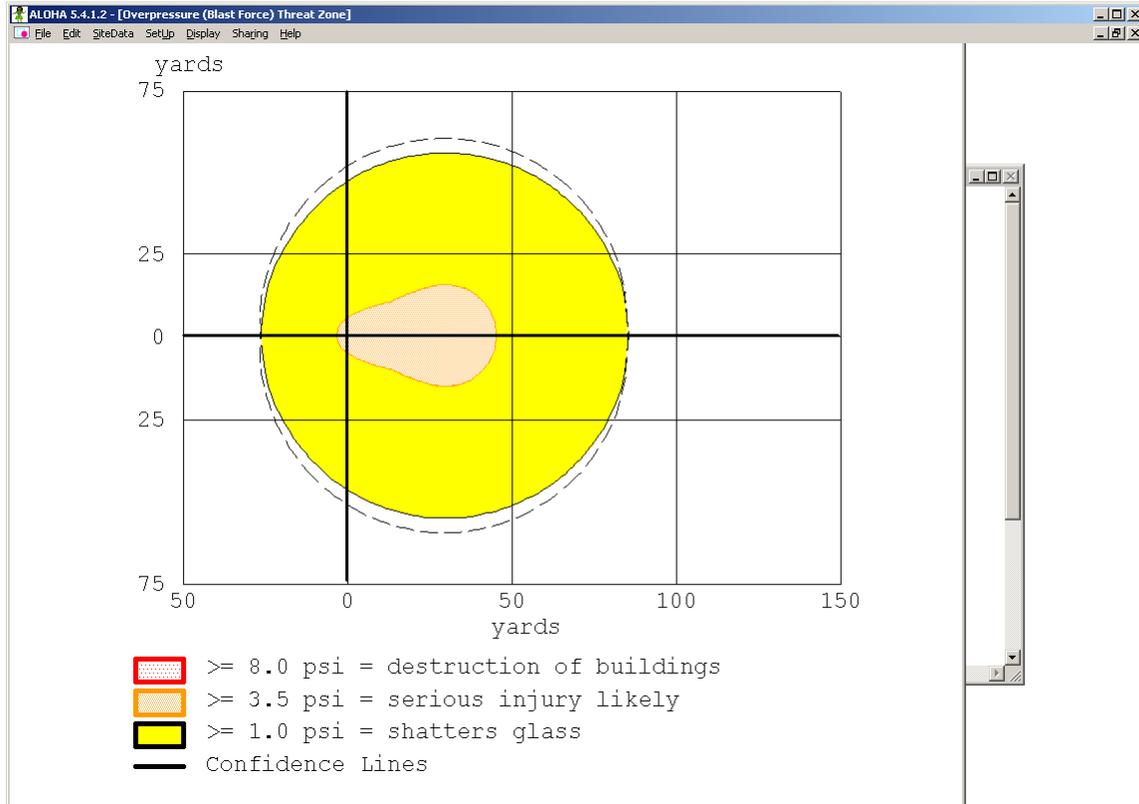
Level of congestion : Help
(in the flammable part of the vapor cloud)

congested, difficult to walk through (e.g. pipe rack, dense forest)

uncongested, easy to walk through (e.g. residential neighborhood)

OK Cancel

6. Select “OK” and accept the default Level of Concern



7. Review the Threat Zone section of the Text Summary. Compare to the previous Toxic and Flammable Area Threat Zone information. Notice that Toxic LOC units are “ppm”, Flammable LOC units are “%”, and Explosive LOC units are “psi”.

NOTE: Next month’s CAMEO Exercise will provide methods for displaying multiple ALOHA Threat Zones on MARPLOT maps, and Google Earth products.

ANSWERS:

CAMEO Chemicals

1. Use CAMEO Chemicals to gather information for the various chemicals. (CAMEO Companion pages 31-34)
 - a. What is the product in the tanker? **DIMETHYL ETHER**
 - b. Evaluate the hazards of this material. Determine what hazards pose the most immediate threat to the responders and to the community.
The material is both Flammable and Toxic. It is difficult to assess which is the “most immediate threat” to the responders and the community. Based on my reading of the chemical data for Dimethyl Ether, I would most likely consider Flammability the most immediate threat to the responders, and the Toxicity the most immediate threat to the community. Others who read and evaluate the CAMEO Chemicals and ERG texts may have a different opinion.
 - c. Use the ERG to determine the Immediate Isolation Zone and the Downwind Protection Distance; display both areas on MARPLOT.
As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions. Consider initial downwind evacuation for at least 800 meters (1/2 mile).
 - d. Based on the information, what level of protection would you recommend for entry into the Hot Zone?
Since Dimethyl Ether is listed as an Inhalation Hazard, I would recommend Level B as the minimum level of protection. Again, some individuals might specify Level A, and I would certainly not argue with that assessment.
2. Use the CAMEO Chemicals “Predict Reactivity” module to evaluate the potential reactive hazards for this incident. (CAMEO Companion pages 34-35)
 - a. Add a listing of materials that could be present at the incident scene to the CAMEO Chemicals “My Chemicals” list (examples: gasoline, diesel, anti-freeze, brake fluid, etc)
 - b. Use the CAMEO Chemicals “Predict Reactivity” module to evaluate the reactive possibilities.
Dimethyl Ether does not appear to be reactive with Gasoline, Diesel, Brake Fluid, or Anti-Freeze. It would potentially react with battery acid.
 - c. Is this material Water-Reactive?
Yes.

ALOHA

Question: which dispersion model (Gaussian or Heavy Gas) is selected by ALOHA for this incident? Why would ALOHA suggest using the Tank Source model for this incident?

Answer: ALOHA selected the Heavy Gas dispersion model, based on the molecular weight of Dimethyl Ether = 46.07. The “flash boil” message is intended to inform ALOHA users that the Threat Zone results may be adversely affected by the fact that ALOHA does not account for the “two-phase” flow occurrence, and that the user should evaluate the release

- 1) using both the Gaussian and Heavy Gas dispersion models in some cases (for example ALOHA suggests using both dispersion models for Ammonia modeling), and/or**
- 2) by using the Tank source option when the user can determine the Tank Parameters, Hole Size, Hole Location, and other information necessary to operate the ALOHA Tank model.**

For Dimethyl Ether, ALOHA did not specifically suggest using both dispersion models; however, I generally will at least take a look at both dispersion models every time ALOHA displays the Flash / Boil message.

Question: Which hazard do you wish to utilize for this incident? Why? Is it possible to display Threat Zones for all three Hazards?

ALOHA can analyze only one “hazard” at a time. Users must choose between the various hazard analyses available (Toxicity, Flammable Area, Blast Area, Pool Fire, BLEVE). Users may view the Toxic Threat Zone, then return to the Hazard to Analyze screen to select the Flammable Area or Blast Area as desired. However, selection of a new “hazard” removes the previous ALOHA Threat Zone analysis. ALOHA, by itself, can NOT display all the various Threat Zones at once.

There are methods to use MARPLOT to display multiple ALOHA Threat Zones on maps or aerial photos (CAMEO Companion pages 124-126). The user must first “save” the existing ALOHA Threat Zone as a map object, then return to ALOHA and select a different Hazard to Analyze. These methods will be explored in next month’s CAMEO Monthly Exercise

Question: which dispersion model (Gaussian or Heavy Gas) is correct for this incident? **For Dimethyl Ether, the Heavy Gas model is likely more accurate.**

Question: How does the Release Duration vary between the Direct/Instantaneous source model and the Tank model? What is the difference between the Total Amount Released for the two source models?

The main difference for Release Duration under the various ALOHA source models is this: the Direct Source Release Duration is “user-set”; ALOHA does no release rate calculations but simply accepts the release rate specified by the user.

Under the ALOHA Puddle, Tank, and Gas Pipeline Sources, the Release Duration is “ALOHA-calculated” based on the information entered by the user.

Under the Direct/Instantaneous source model, the Release Duration is always set at 1 minute (60 seconds). Users may input their own Release Duration using the Direct/Continuous source model.

The same applies to the Total Amount Released; it is user-set under the Direct source, and ALOHA-calculated for the other source models.

In the Dimethyl Ether scenario, the amount of product released is lower when using the Tank source, and the time of release (release duration) is longer for the Tank source.

The Total Amount Released difference is due to the fact that ALOHA calculated less than 8000 gallons of product was in the tank initially, based on our input of tank parameters and that the tank was 85% full at the onset of the incident.

Question: How do the Threat Zone distances vary between the Direct/Instantaneous source model and the Tank model?

For the Direct/Instantaneous source model, the Threat Zone distances were far larger than those predicted using the Tank source model. In my example, the Red Threat Zone was 134 yards for the Direct, but only 32 yards for the Tank.

Question: If the “hole” is on the bottom of the tank, the Total Amount Released is 37,342 pounds (all the tank contents). If the “hole” is on the top of the tank, the Total Amount Released is 34,355 pounds. Why? Where is the missing 2,987 pounds?

ALOHA understands the difference between releasing a product from a hole in the bottom of the container and a hole at the top of the container. Obviously, if the material is a liquid and the hole is in the bottom of the container, one would expect all the product to be released. If the hole is at the top of the container, it is possible (depending on the chemical properties of the substance) for less or none of the product to be “released” within the first hour of the incident.

As Dimethyl Ether is a liquefied gas in this example, ALOHA modeled that most, but not all, the product would escape from a hole in the top of the container.

However, as the pressure inside/outside the container equalizes, at some point the product will cease escaping the container; and some of the product will remain in liquid form inside the tank. As the product in the tank heats, the release may begin again. In this example, ALOHA is suggesting that 2,987 pounds of Dimethyl Ether may remain in the tank 1 hour after the incident began.