CAMEO Refresher Exercise Set: November, 2010
Train Derailment Exercise

Scenario:

At 6:30 am on December 1, 2010, a freight train accident resulted in a derailment of 11 railcars. The derailment occurred at _____ and _____ in your local community. Responders have secured the immediate area, and have obtained some limited information on the materials contained in the 11 railcars. While the materials involved present a number of hazards, responders are particularly concerned about the materials in the following railcars:

UN # 1789
UN # 2428
Acetone
CAS # 108-91-8

At present, none of the railcars appear to be leaking any material. However, the four railcars listed above have sustained noticeable damage.

Current weather conditions are as follows:

Wind: from the southwest; 16 mph with gusts to 22 mph (obtained from local airport)

Ground Roughness: open country	Cloud Cover: Clear Skies
Air Temperature: 35° F	Stability Class: D
No Inversion Height	Relative Humidity: 22%

The forecast is calling for the following weather conditions at noon:

Wind: from the West; 12 mph with gusts to 22 mph (obtained from local airport)

Ground Roughness: open country	Cloud Cover: Clear Skies
Air Temperature: 55° F	Stability Class: D
No Inversion Height	Relative Humidity: 33%

You are directed to operate CAMEO and supply information to Incident Command for the duration of this event.

CAMEO Chemicals

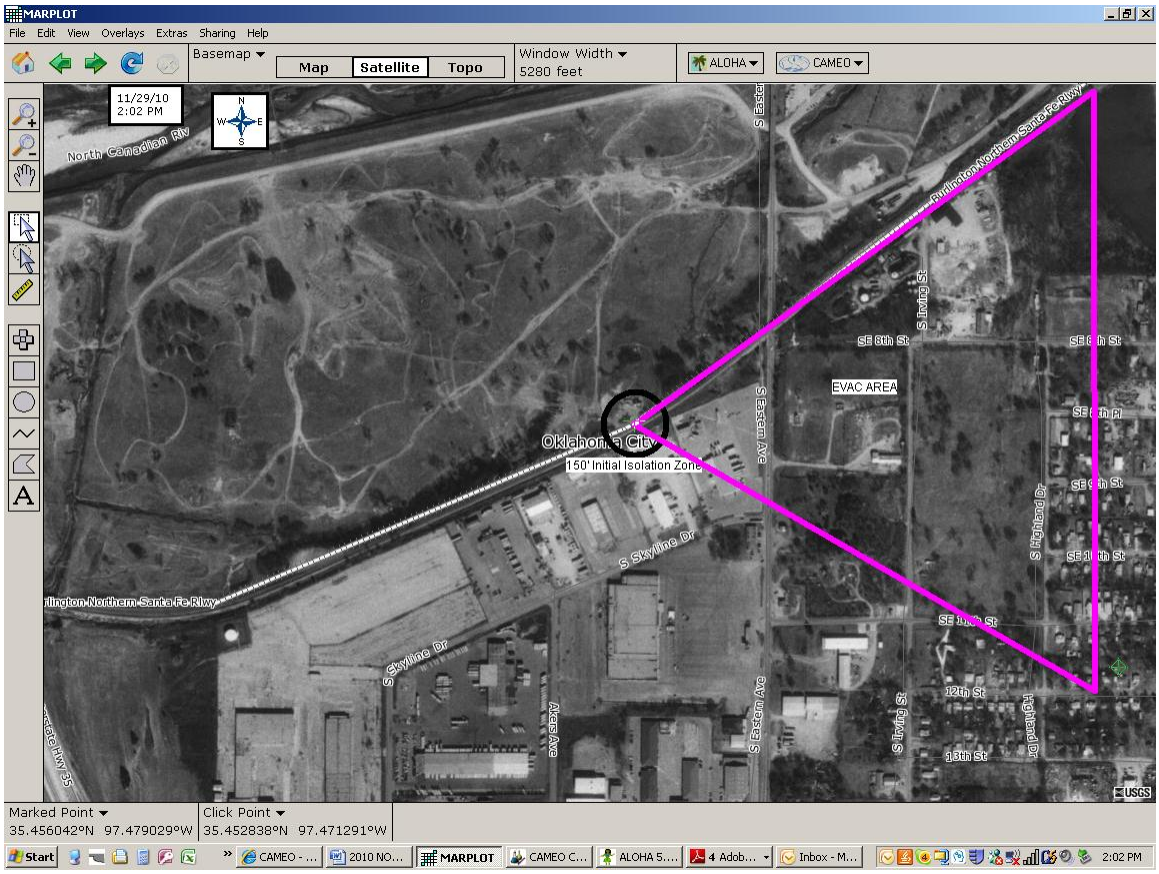
1. Use CAMEO Chemicals to gather information for the various chemicals. (CAMEO Companion pages 31-34)
    a. Are these materials liquid, solid, or gas?
    b. Is it likely that these materials are carried in Liquid Tankers or Pressurized Tankers?
    c. What are the primary hazards associated with these materials?

2. Use the CAMEO Chemicals "Predict Reactivity" module to evaluate the potential reactive hazards for this incident. (CAMEO Companion pages 34-35)

3. Determine the Initial Isolation Zone and Evacuation distances appropriate for this scenario. (CAMEO Companion pages 31-34)

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 "Polygon" drawing tool to display the largest ERG-suggestion downwind evacuation area
7. Copy and paste a screenshot of the mapped area from MARPLOT to WORD. (CAMEO Companion pages 85)



ALOHA

1. Determine which, if any, of these materials can be modeled using ALOHA.
   - ***a.*** For the first ALOHA scenario, use Acetone
   - ***b.*** Model for the Toxic, Vapor Cloud Explosion, and BLEVE zones
   - ***c.*** Repeat for the other substances

2. Use the following weather data:

   Wind: 16 miles/hour from SW at 10 meters
   Ground Roughness: open country — Cloud Cover: 0 tenths
   Air Temperature: 35° F — Stability Class: D
   No Inversion Height — Relative Humidity: 22%

3. Use "Tank" for your Source option. (Consult http://worldtraderef.com/WTR_site/Rail_Cars/Guide_to_Rail_Cars.asp to determine the estimated Tank dimensions)

Tanker

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Dimensions

Length over couplers	59' 9"	18.21 m
Length over strikers	57' $1^{1}/_{2}$"	17.41 m
Truck centers	46' $3^{1}/_{4}$"	14.10 m
Height, extreme	15' 5"	4.70 m
Width, extreme	10' $7^{1}/_{2}$"	3.24 m

Weight/Capacity

Light weight	65,700 lbs	29,801 kg
Gross rail load	263,000 lbs	119,295 kg
Shell full capacity	30,000 gallons	113,562 liters

Tank

Inside diameter	9'$11^{1}/_{8}$"	3.03 m
Length over tank heads	53' $10^{13}/_{16}$"	16.43 m
Tank slope	$^{1}/_{4}$" per foot	-
Plate thickness	$^{7}/_{16}$"	1.11 cm
Manway nozzle	20"	50.8 cm

NOTE: *from the above railcar guide, I input a 30,000 gallon tank capacity and 54 feet tank length to ALOHA; ALOHA then determined a Tank Diameter of 9.72 feet.*

SITE DATA:
Location: OKLAHOMA CITY, OKLAHOMA
Building Air Exchanges Per Hour: 1.26 (unsheltered single storied)
Time: December 1, 2010 0630 hours CST (user specified)

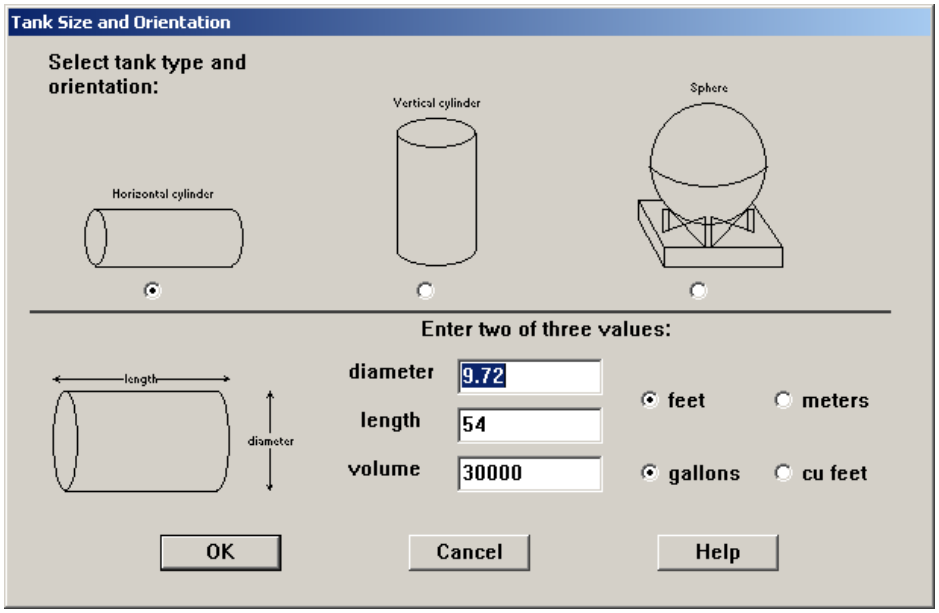
CHEMICAL DATA:
Chemical Name: ACETONE Molecular Weight: 58.08 g/mol
TEEL-1: 200 ppm TEEL-2: 3200 ppm TEEL-3: 5700 ppm
LEL: 26000 ppm UEL: 128000 ppm
Ambient Boiling Point: 130.7° F
Vapor Pressure at Ambient Temperature: 0.10 atm
Ambient Saturation Concentration: 105,579 ppm or 10.6%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 16 miles/hour from sw at 10 meters
Ground Roughness: open country Cloud Cover: 0 tenths
Air Temperature: 35° F Stability Class: D
No Inversion Height Relative Humidity: 22%

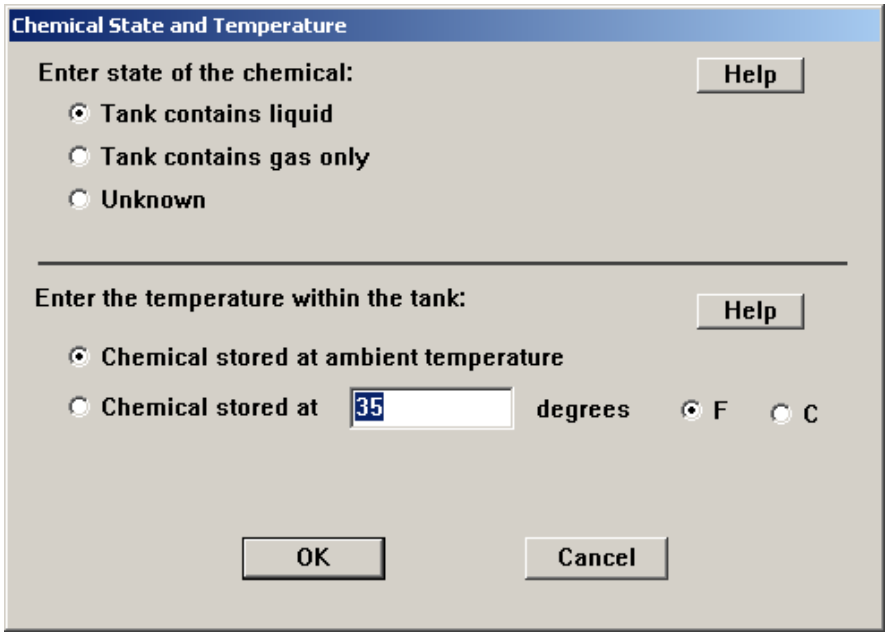
SOURCE STRENGTH:
BLEVE of flammable liquid in horizontal cylindrical tank
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid
Internal Storage Temperature: 35° F
Chemical Mass in Tank: 172,918 pounds
Tank is 85% full
Percentage of Tank Mass in Fireball: 100%
Fireball Diameter: 272 yards Burn Duration: 15 seconds

Estimating BLEVE, VCE, and Toxic Threat Zone data: ACETONE

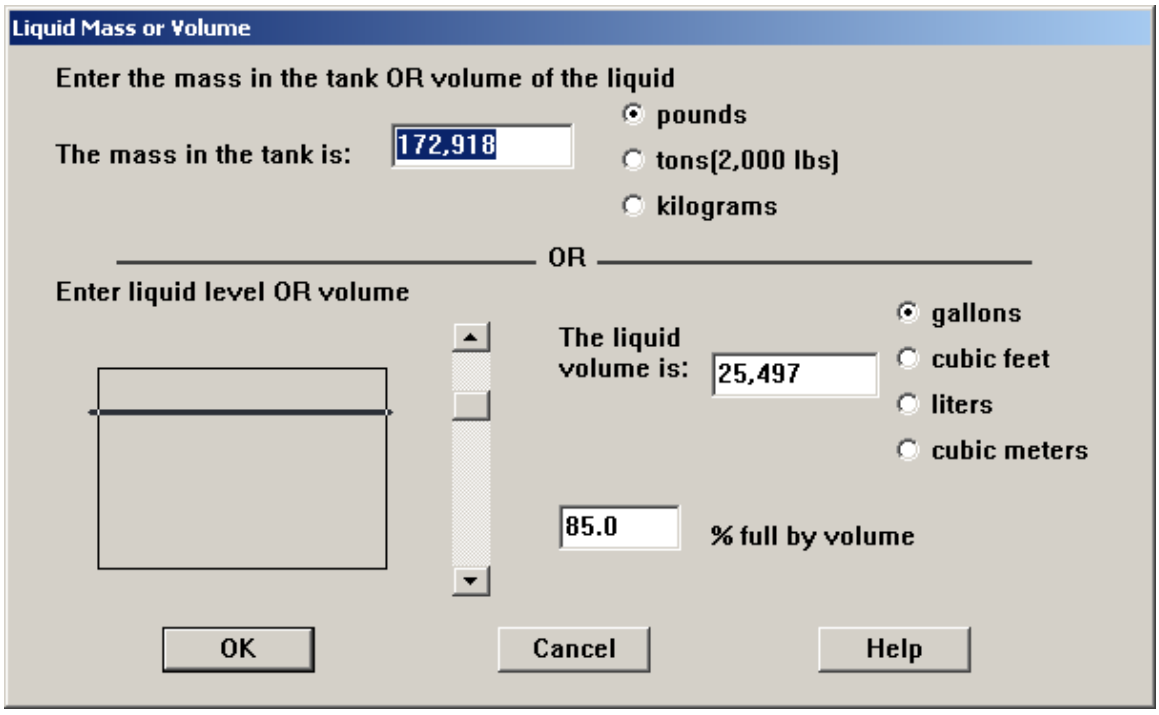
1. Enter the Tank dimensions as given above



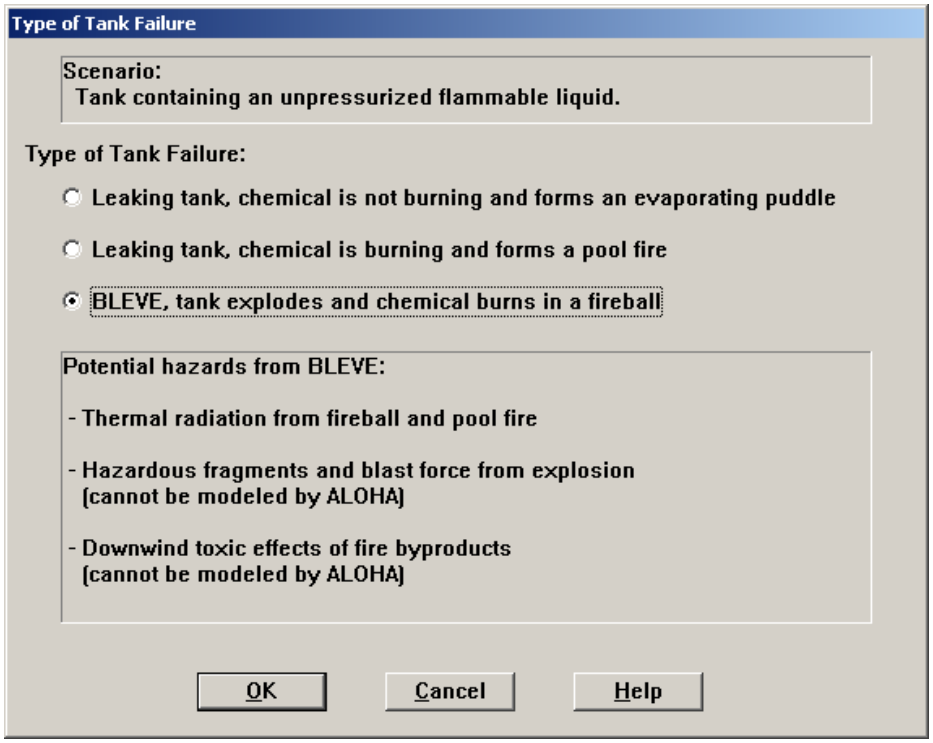
2. Enter Chemical State and Temperature as "Liquid" and "Ambient"



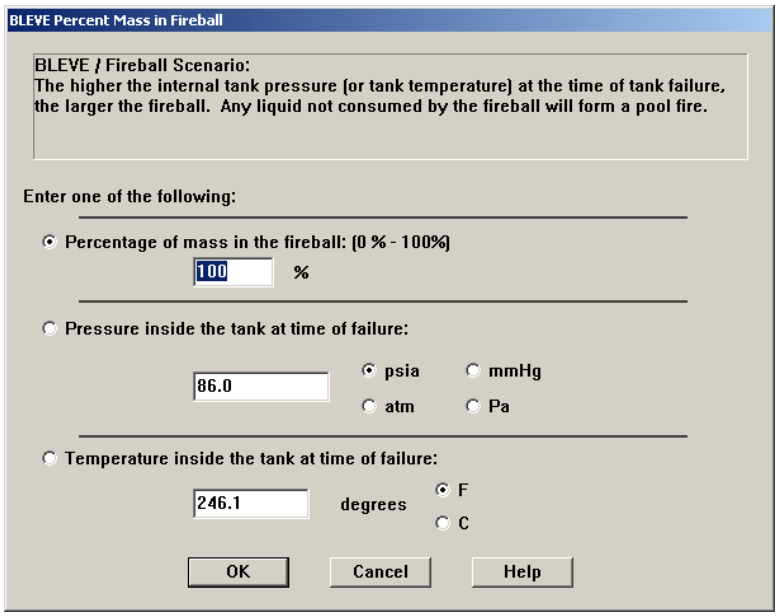
3. Assume the railcar is essentially completely full at the time of the derailment and enter “85” % full by volume



4. Select “BLEVE” as the Type of Tank Failure

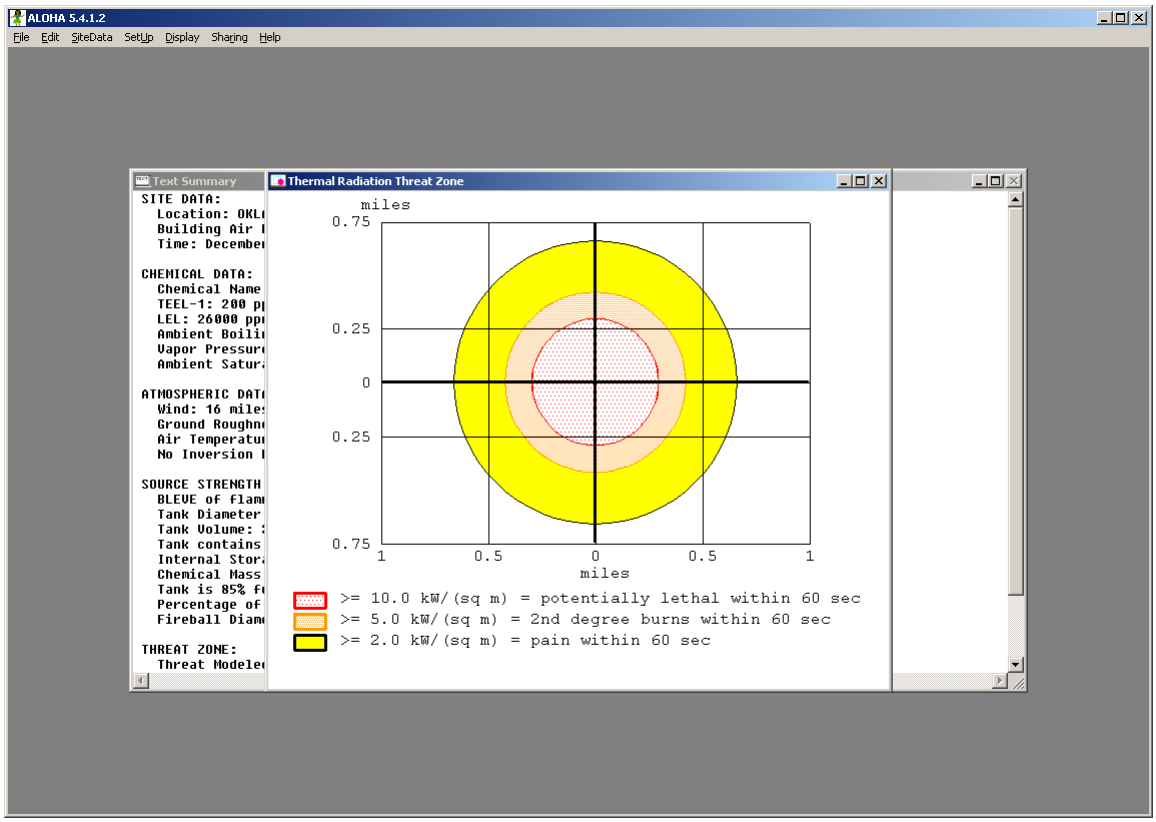


5. Accept the ALOHA default values for the BLEVE



BLEVE AREA Threat Zone

Select the Display / Threat Zone menu



SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid
Internal Storage Temperature: 35° F
Chemical Mass in Tank: 172,918 pounds
Tank is 85% full
Percentage of Tank Mass in Fireball: 100%
Fireball Diameter: 272 yards Burn Duration: 15 seconds

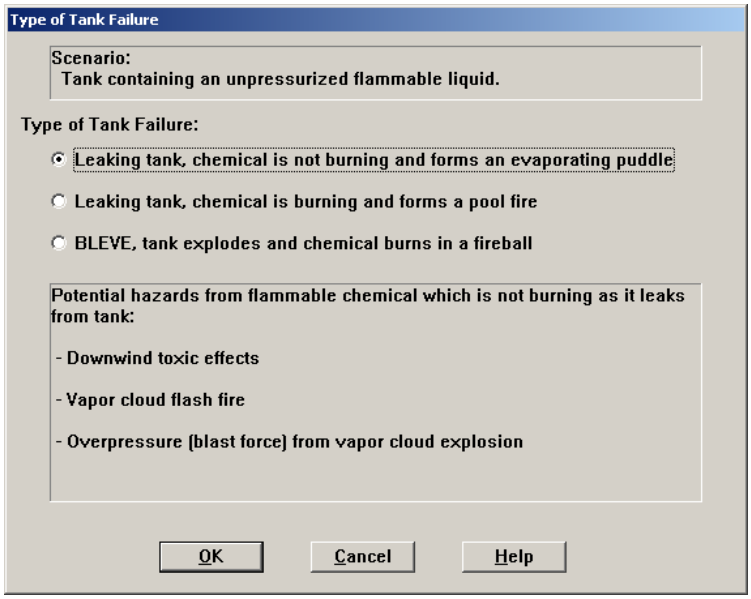
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball
Red : 520 yards --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
Orange: 741 yards --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
Yellow: 1164 yards --- (2.0 kW/(sq m) = pain within 60 sec)

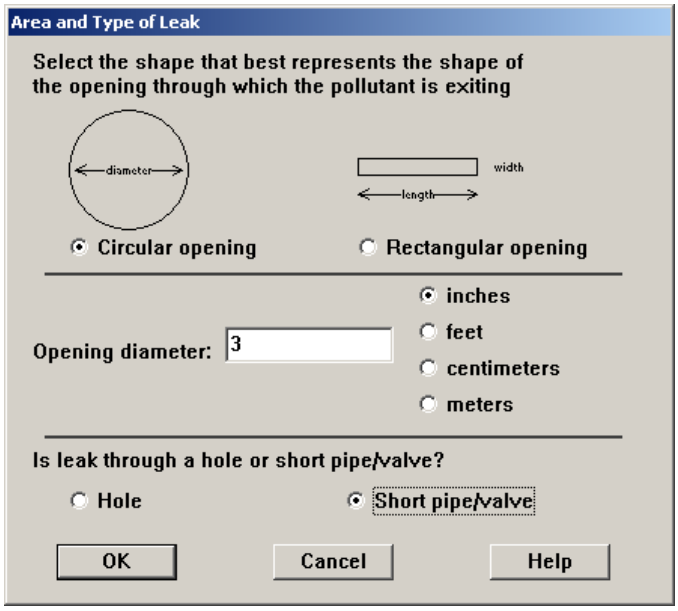
VAPOR CLOUD EXPLOSION AREA

Using a 3 inch short pipe or valve located at the bottom of the tank

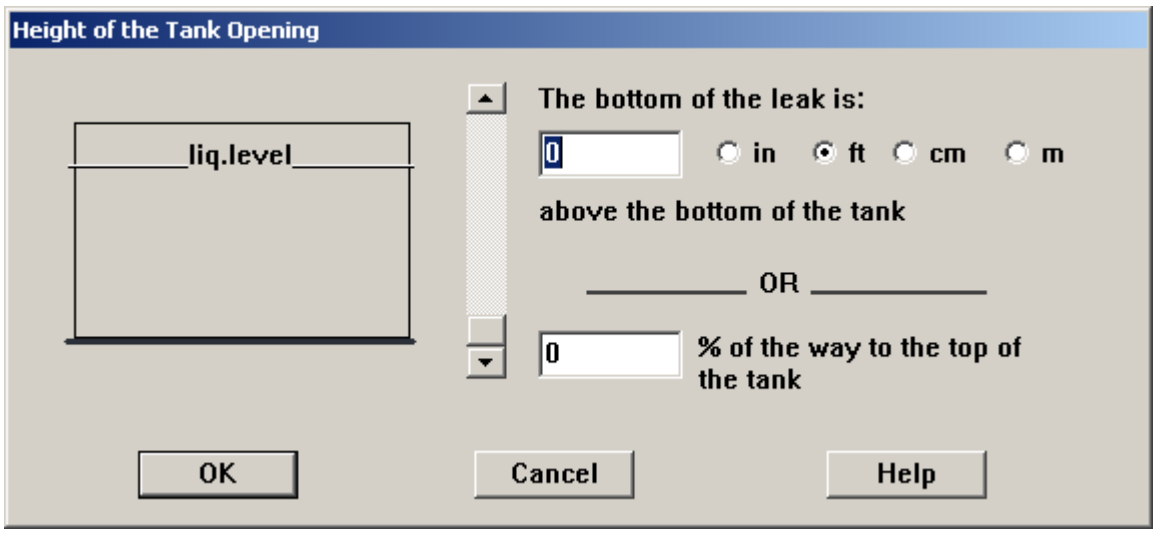
1. Use the same Tank Dimensions, Chemical State, and Liquid Volume as above
2. Select "Leaking tank, chemical is not burning and forms an evaporating puddle" as the Type of Tank Failure



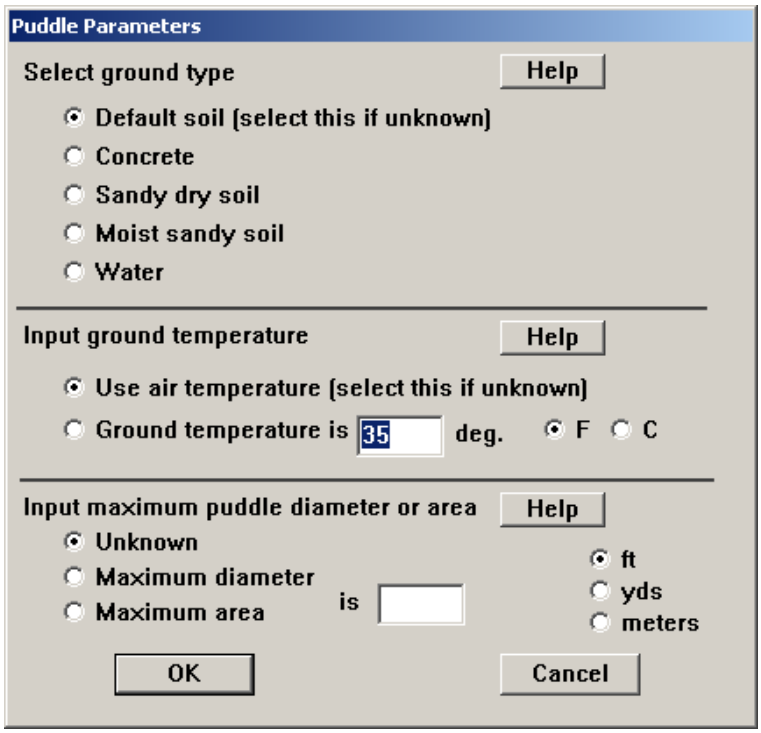
3. Enter "Circular opening", "3" inches; and "Short pipe or valve"



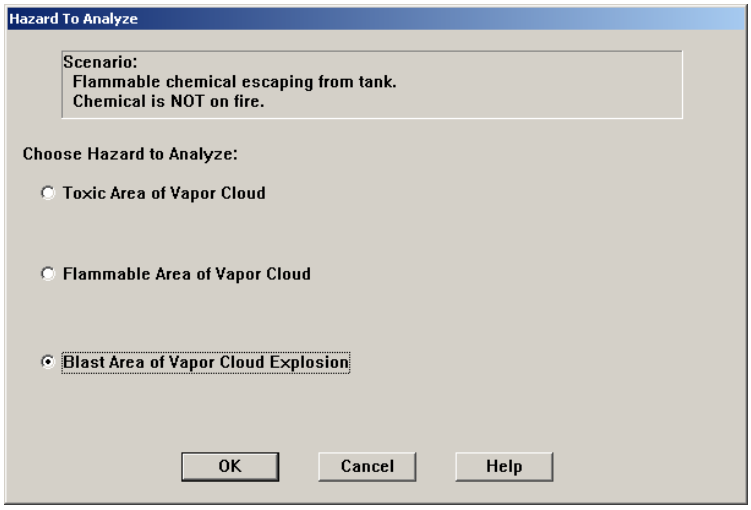
4. Enter “0” for the bottom of the leak is value



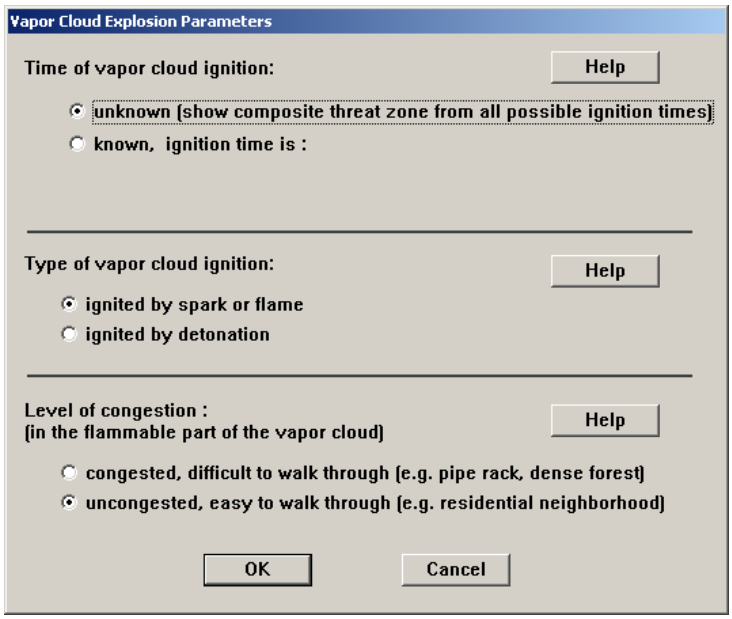
5. Select “Default soil”; “Use air temperature”; and “Unknown” for the Puddle Parameters



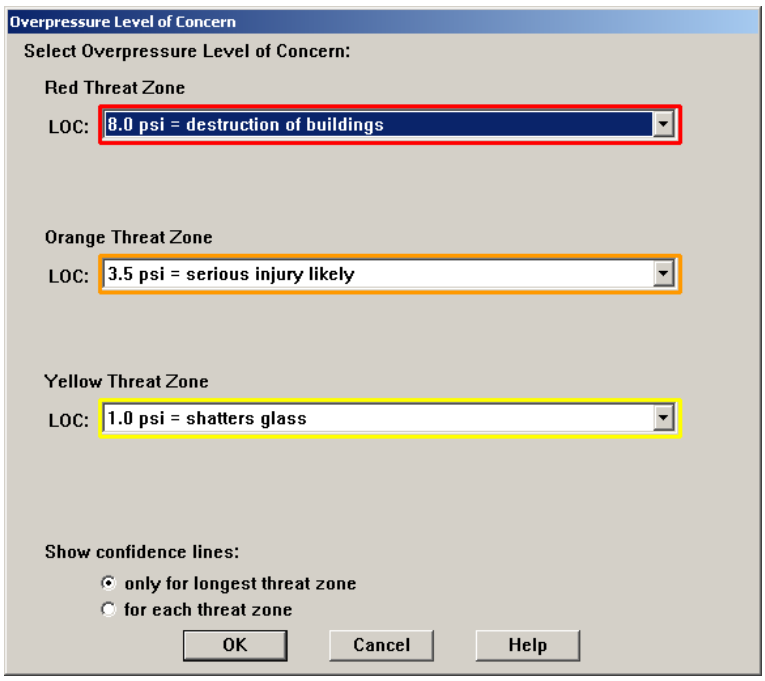
6. Select “Blast Area of Vapor Cloud” as the Hazard to Analyze



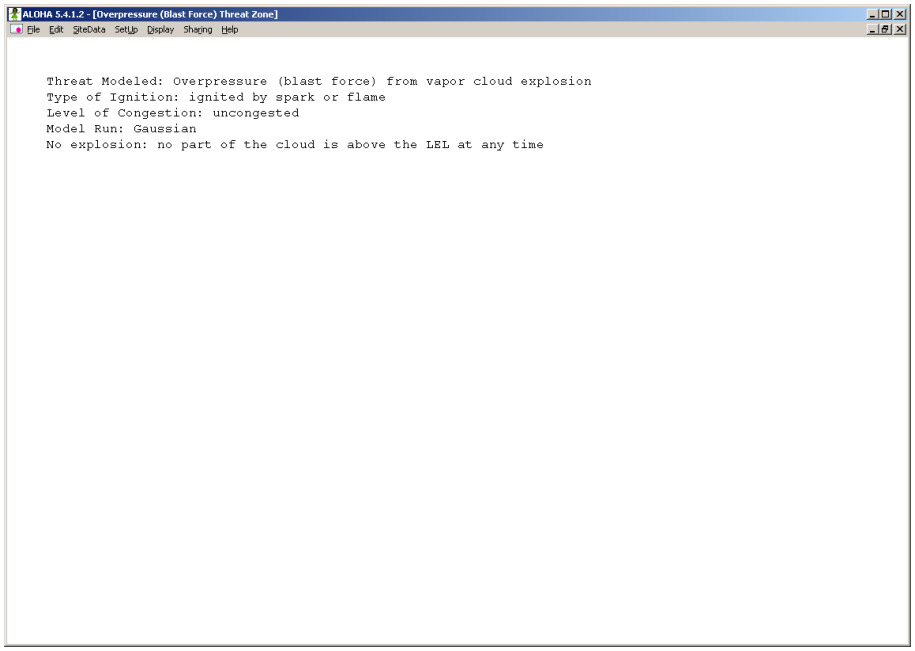
7. Select “unknown”; “ignited by spark or flame”; and “uncongested” for the Vapor Cloud Explosion Parameters



8. Accept the ALOHA defaults for the Level of Concern values



9. Select the Display / Threat Zone menu



Note: ALOHA predicts there will not be any explosion from an ACETONE release with these conditions because the LEL for Acetone is never exceeded.

SOURCE STRENGTH:

Leak from short pipe or valve in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid Internal Temperature: 35° F
Chemical Mass in Tank: 172,918 pounds
Tank is 85% full
Circular Opening Diameter: 3 inches
Opening is 0 feet from tank bottom
Ground Type: Default soil
Ground Temperature: equal to ambient
Max Puddle Diameter: Unknown
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 327 pounds/min
(averaged over a minute or more)
Total Amount Released: 13,653 pounds
Note: The chemical escaped as a liquid and formed an evaporating puddle.
The puddle spread to a diameter of 50 yards.

THREAT ZONE:

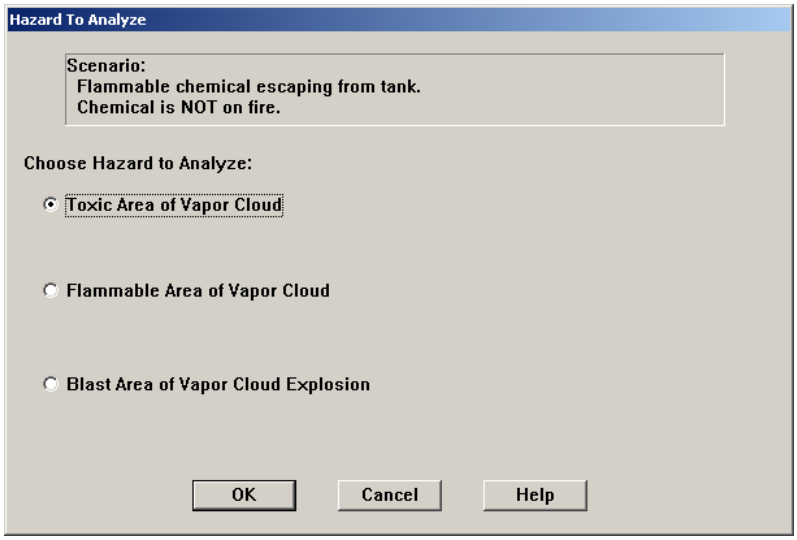
Threat Modeled: Overpressure (blast force) from vapor cloud explosion
Type of Ignition: ignited by spark or flame
Level of Congestion: uncongested
Model Run: Gaussian
No explosion: no part of the cloud is above the LEL at any time

TOXIC THREAT ZONE AREA

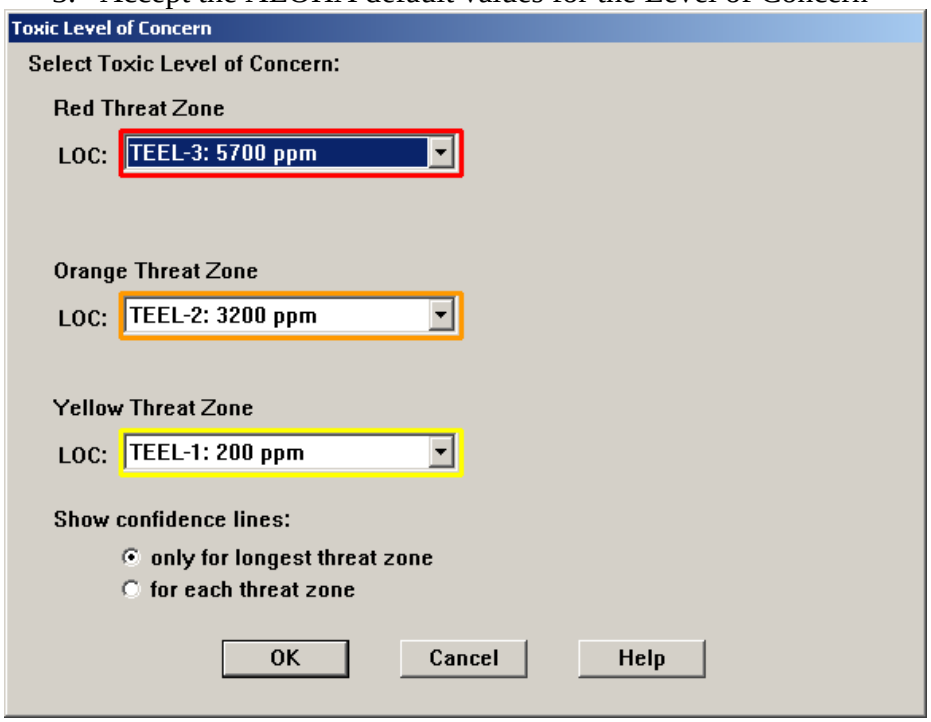
Using a 3 inch short pipe or valve located at the bottom of the tank

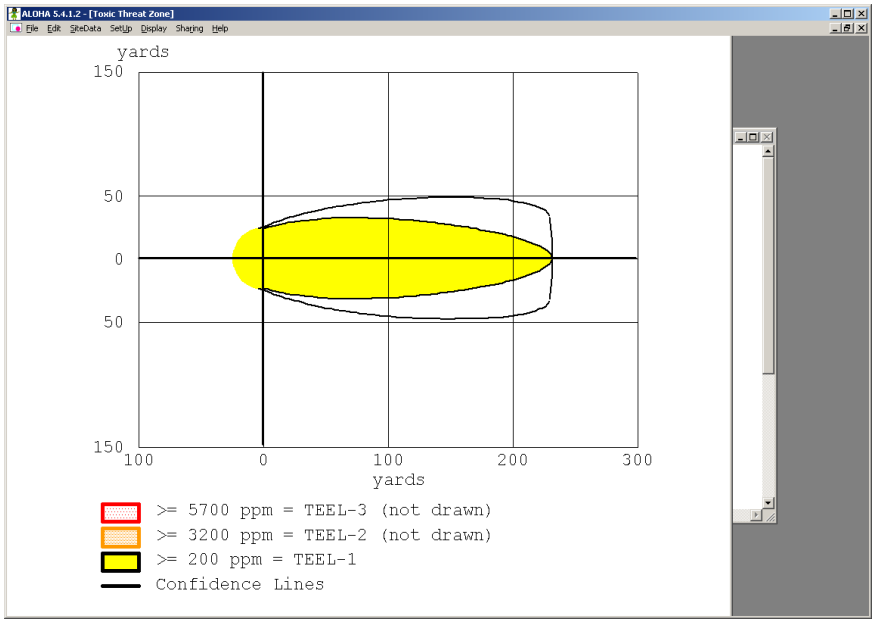
1. Select the Display / Threat Zone menu

2. Select "Toxic Area of Vapor Cloud" as the Hazard to Analyze



3. Accept the ALOHA default values for the Level of Concern





SOURCE STRENGTH:

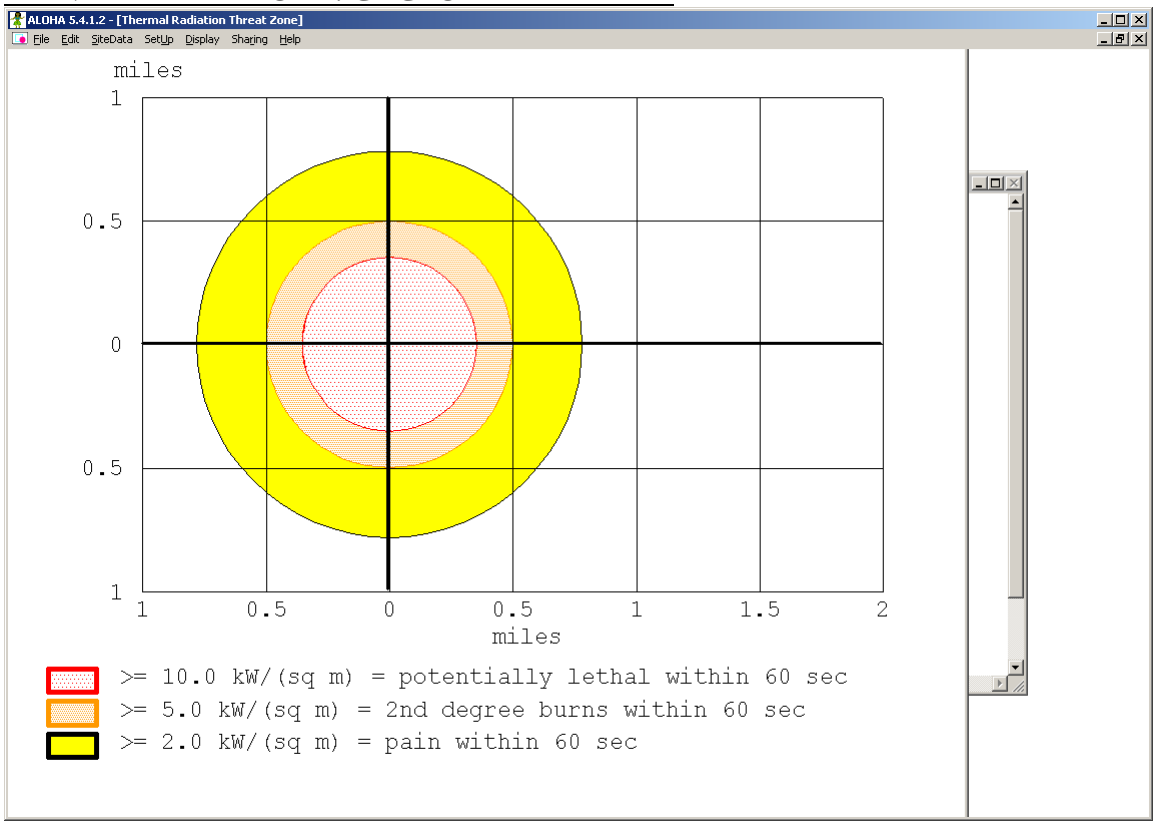
Leak from short pipe or valve in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid Internal Temperature: 35° F
Chemical Mass in Tank: 172,918 pounds
Tank is 85% full
Circular Opening Diameter: 3 inches
Opening is 0 feet from tank bottom
Ground Type: Default soil
Ground Temperature: equal to ambient
Max Puddle Diameter: Unknown
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 327 pounds/min
(averaged over a minute or more)
Total Amount Released: 13,653 pounds
Note: The chemical escaped as a liquid and formed an evaporating puddle.
The puddle spread to a diameter of 50 yards.

THREAT ZONE:

Model Run: Gaussian
Red : 24 yards --- (5700 ppm = TEEL-3)
Note: Threat zone was not drawn because effects of near-field patchiness
make dispersion predictions less reliable for short distances.
Orange: 29 yards --- (3200 ppm = TEEL-2)
Note: Threat zone was not drawn because effects of near-field patchiness
make dispersion predictions less reliable for short distances.
Yellow: 232 yards --- (200 ppm = TEEL-1)

REPEAT THE ABOVE STEPS USING CHEMICAL "CYCLOHEXYLAMINE"

BLEVE THREAT ZONE: CYCLOHEXYLAMINE



SITE DATA:
Location: OKLAHOMA CITY, OKLAHOMA
Building Air Exchanges Per Hour: 1.26 (unsheltered single storied)
Time: December 1, 2010 0630 hours CST (user specified)

CHEMICAL DATA:
Chemical Name: CYCLOHEXYLAMINE Molecular Weight: 99.17 g/mol
AEGL-1(60 min): 1.8 ppm AEGL-2(60 min): 8.6 ppm AEGL-3(60 min): 30 ppm
LEL: 6600 ppm UEL: 93000 ppm
Ambient Boiling Point: 270.7° F
Vapor Pressure at Ambient Temperature: 0.0030 atm
Ambient Saturation Concentration: 3,130 ppm or 0.31%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 16 miles/hour from sw at 10 meters
Ground Roughness: open country Cloud Cover: 0 tenths
Air Temperature: 35° F Stability Class: D
No Inversion Height Relative Humidity: 22%

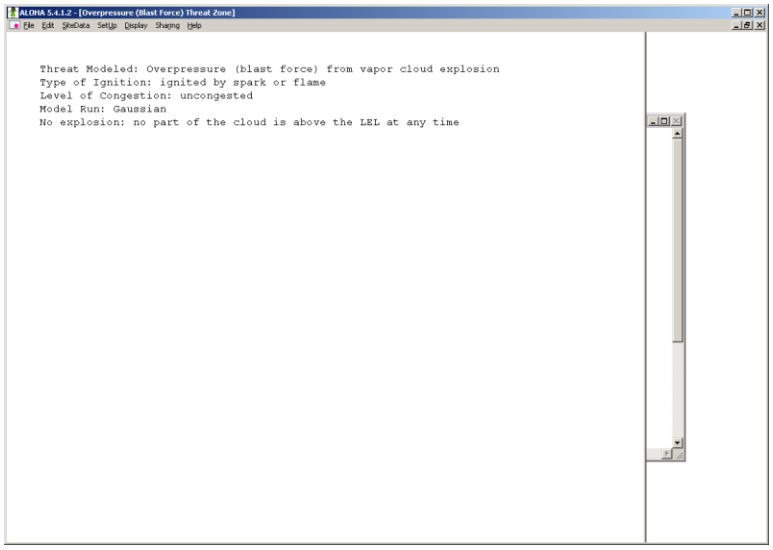
SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid
Internal Storage Temperature: 35° F
Chemical Mass in Tank: 187,668 pounds
Tank is 85% full
Percentage of Tank Mass in Fireball: 100%
Fireball Diameter: 279 yards Burn Duration: 15 seconds

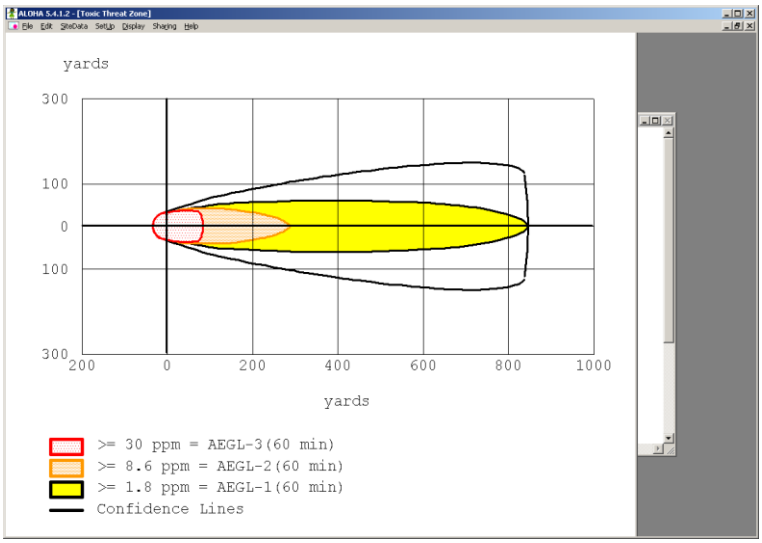
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball
Red : 620 yards --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
Orange: 878 yards --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
Yellow: 1375 yards --- (2.0 kW/(sq m) = pain within 60 sec)

VAPOR CLOUD EXPLOSION THREAT ZONE: CYCLOHEXYLAMINE



TOXIC AREA THREAT ZONE: CYCLOHEXYLAMINE



SITE DATA:
Location: OKLAHOMA CITY, OKLAHOMA
Building Air Exchanges Per Hour: 1.26 (unsheltered single storied)
Time: December 1, 2010 0630 hours CST (user specified)

CHEMICAL DATA:
Chemical Name: CYCLOHEXYLAMINE Molecular Weight: 99.17 g/mol
AEGL-1(60 min): 1.8 ppm AEGL-2(60 min): 8.6 ppm AEGL-3(60 min): 30 ppm
LEL: 6600 ppm UEL: 93000 ppm
Ambient Boiling Point: 270.7° F
Vapor Pressure at Ambient Temperature: 0.0030 atm
Ambient Saturation Concentration: 3,130 ppm or 0.31%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 16 miles/hour from sw at 10 meters
Ground Roughness: open country Cloud Cover: 0 tenths
Air Temperature: 35° F Stability Class: D
No Inversion Height Relative Humidity: 22%

SOURCE STRENGTH:
Leak from short pipe or valve in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid Internal Temperature: 35° F
Chemical Mass in Tank: 187,668 pounds
Tank is 85% full
Circular Opening Diameter: 3 inches

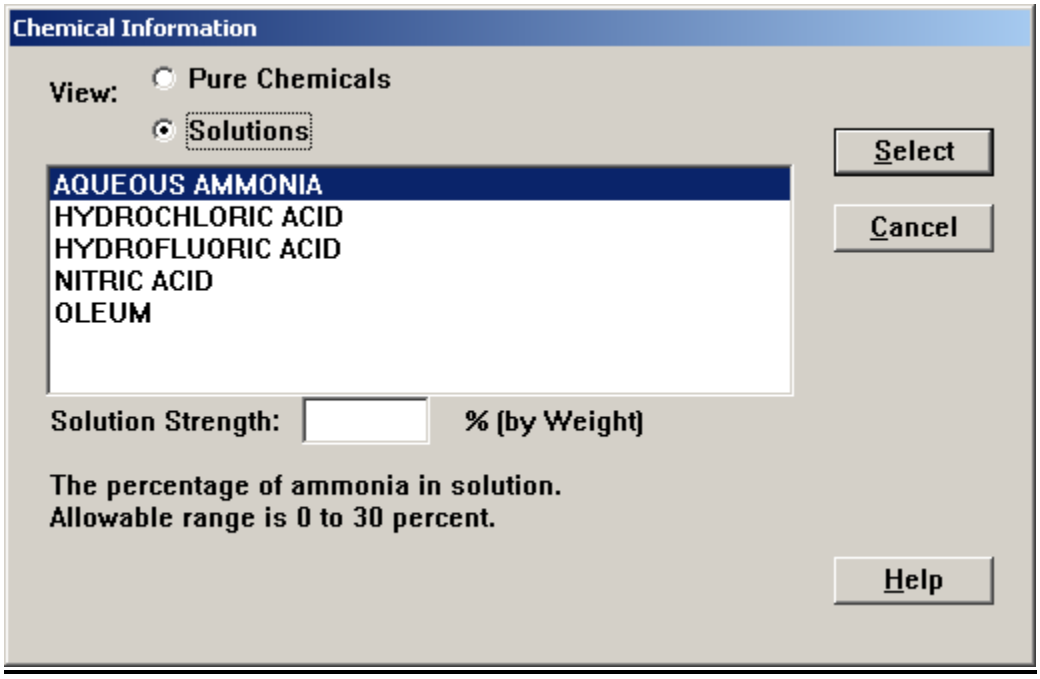
Opening is 0 feet from tank bottom
Ground Type: Default soil
Ground Temperature: equal to ambient
Max Puddle Diameter: Unknown
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 37.3 pounds/min
(averaged over a minute or more)
Total Amount Released: 1,285 pounds
Note: The chemical escaped as a liquid and formed an evaporating puddle.
The puddle spread to a diameter of 66 yards.

THREAT ZONE:
Model Run: Gaussian
Red : 84 yards --- (30 ppm = AEGL-3(60 min))
Orange: 288 yards --- (8.6 ppm = AEGL-2(60 min))
Yellow: 847 yards --- (1.8 ppm = AEGL-1(60 min))

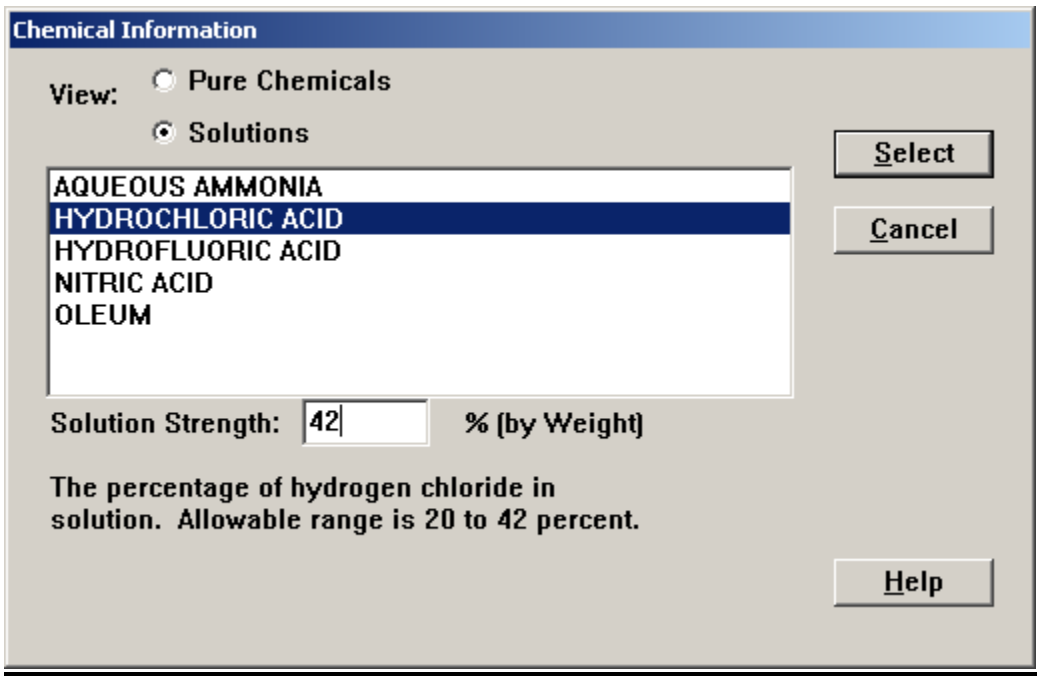
REPEAT THE ABOVE STEPS USING CHEMICAL "HYDROCHLORIC ACID, SOLUTION"

1. Select the Setup / Chemical menu

2. Select "Solutions"

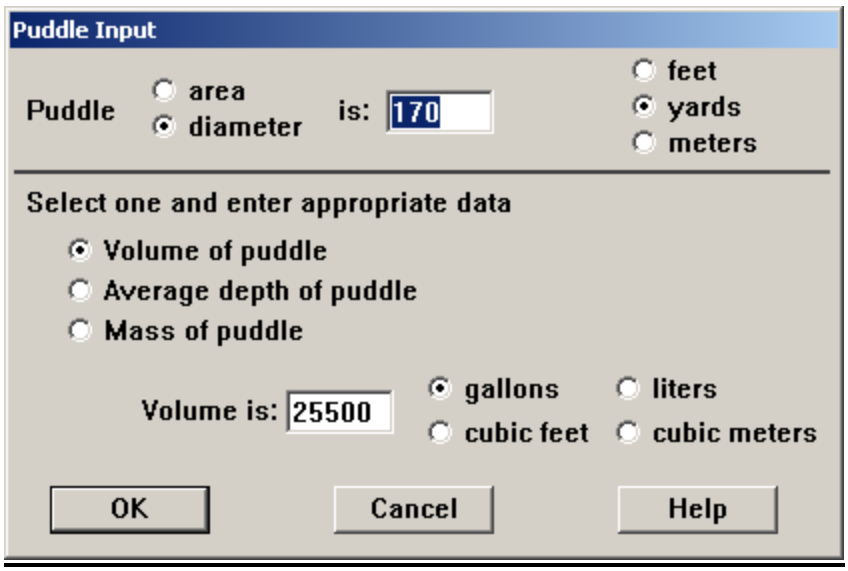


3. Select “Hydrochloric Acid” and enter “42” % (by Weight)

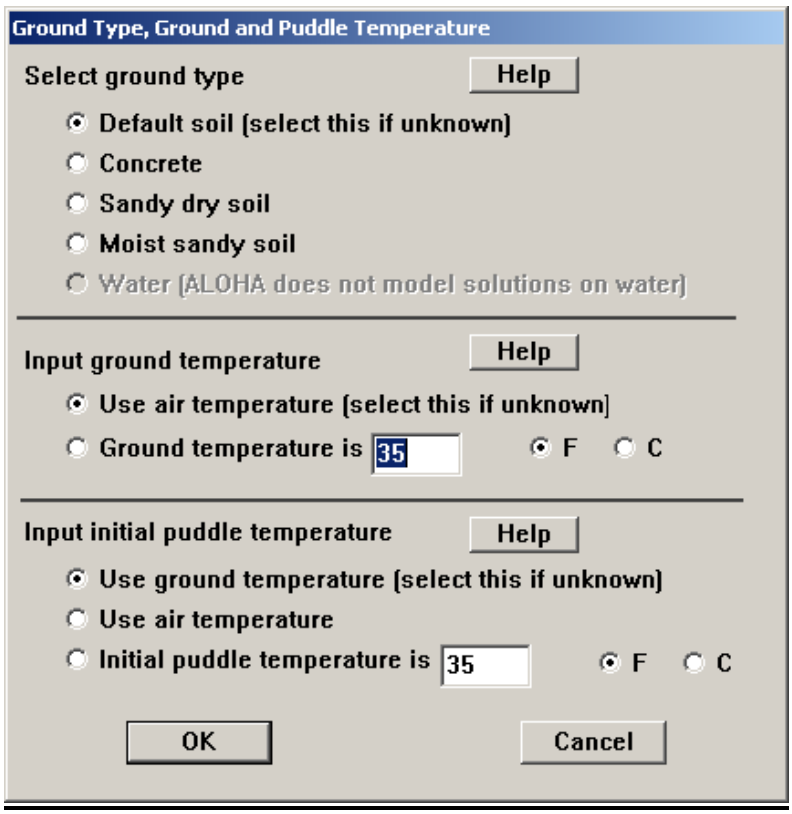


4. Select the Setup / Source / Puddle menu

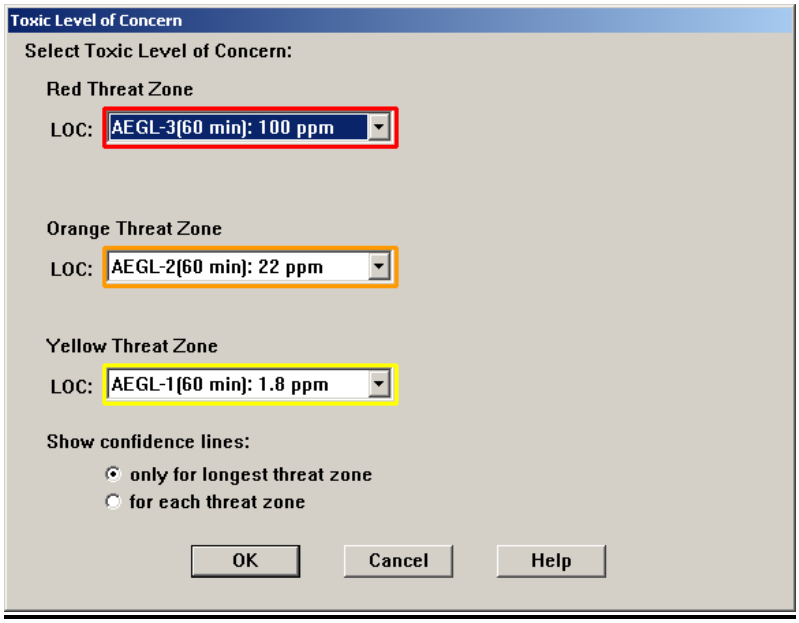
5. Enter diameter = 170 yards and Volume = 25,500 gallons (which is 85% of the 30,000 gallon tank capacity)



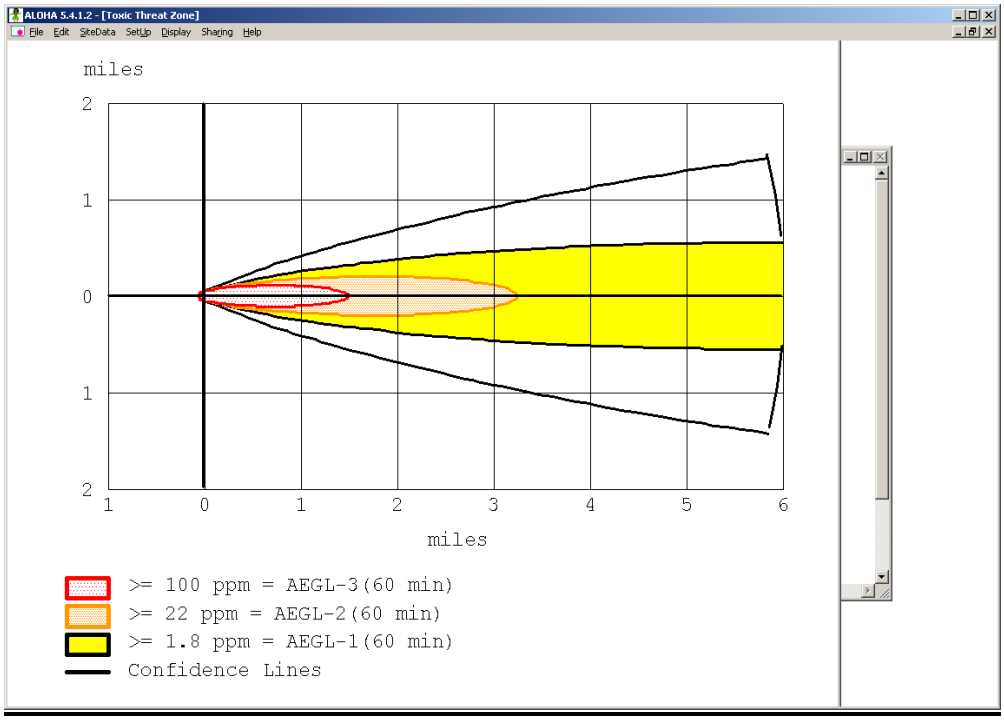
6. Select "Default"; "Air Temp"; and "Ground Temp"



7. Select the Display / Threat Zone menu



8. Accept the ALOHA default values for the Level of Concern



SITE DATA:
Location: OKLAHOMA CITY, OKLAHOMA
Building Air Exchanges Per Hour: 1.26 (unsheltered single storied)
Time: December 1, 2010 0630 hours CST (user specified)

CHEMICAL DATA:
Chemical Name: HYDROCHLORIC ACID
Solution Strength: 42% (by weight)
Ambient Boiling Point: 68.9° F
Partial Pressure at Ambient Temperature: 0.36 atm
Ambient Saturation Concentration: 381,055 ppm or 38.1%
Hazardous Component: HYDROGEN CHLORIDE
Molecular Weight: 36.46 g/mol
AEGL-1(60 min): 1.8 ppm AEGL-2(60 min): 22 ppm AEGL-3(60 min): 100 ppm
IDLH: 50 ppm

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 16 miles/hour from sw at 10 meters
Ground Roughness: open country Cloud Cover: 0 tenths
Air Temperature: 35° F Stability Class: D
No Inversion Height Relative Humidity: 22%

SOURCE STRENGTH:
Evaporating Puddle
Puddle Diameter: 170 yards Puddle Volume: 25500 gallons
Ground Type: Default soil Ground Temperature: 35° F
Initial Puddle Temperature: Ground temperature
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 8,090 pounds/min
(averaged over a minute or more)
Total Amount Hazardous Component Released: 42,025 pounds

THREAT ZONE:
Model Run: Gaussian
Red : 1.5 miles --- (100 ppm = AEGL-3(60 min))
Orange: 3.3 miles --- (22 ppm = AEGL-2(60 min))
Yellow: greater than 6 miles --- (1.8 ppm = AEGL-1(60 min))

Notice ALOHA does not offer either "BLEVE" or "Vapor Cloud Explosion" as hazard to Analyze choices for the Hydrochloric Acid. However, the Toxic Threat Zone Area for the Hydrochloric is very large when compared to the Threat Zones for Cyclohexylamine and Acetone.

Notice that for all three chemicals, ALOHA predicts the length of time for the liquid to completely volatize is greater than one hour. You can find this by reviewing the SOURCE STRENGTH part of the ALOHA Text Summary.

ACETONE:
SOURCE STRENGTH:
Leak from short pipe or valve in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid Internal Temperature: 35° F
Chemical Mass in Tank: 172,918 pounds
Tank is 85% full
Circular Opening Diameter: 3 inches
Opening is 0 feet from tank bottom
Ground Type: Default soil
Ground Temperature: equal to ambient
Max Puddle Diameter: Unknown
Release Duration: **ALOHA limited the duration to 1 hour**
Max Average Sustained Release Rate: 327 pounds/min
(averaged over a minute or more)
Total Amount Released: **13,653 pounds**
Note: The chemical escaped as a liquid and formed an evaporating puddle.
The puddle spread to a diameter of 50 yards.

CYCLOHEXYLAMINE:
SOURCE STRENGTH:
Leak from short pipe or valve in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 9.72 feet Tank Length: 54 feet
Tank Volume: 30000 gallons
Tank contains liquid Internal Temperature: 35° F
Chemical Mass in Tank: 187,668 pounds
Tank is 85% full
Circular Opening Diameter: 3 inches
Opening is 0 feet from tank bottom
Ground Type: Default soil
Ground Temperature: equal to ambient
Max Puddle Diameter: Unknown
Release Duration: **ALOHA limited the duration to 1 hour**
Max Average Sustained Release Rate: 37.3 pounds/min
(averaged over a minute or more)
Total Amount Released: **1,285 pounds**
Note: The chemical escaped as a liquid and formed an evaporating puddle.
The puddle spread to a diameter of 66 yards.

HYDROCHLORIC ACID:
SOURCE STRENGTH:
Evaporating Puddle
Puddle Diameter: 170 yards Puddle Volume: 25500 gallons
Ground Type: Default soil Ground Temperature: 35° F
Initial Puddle Temperature: Ground temperature
Release Duration: ALOHA **limited the duration to 1 hour**
Max Average Sustained Release Rate: 8,090 pounds/min
(averaged over a minute or more)
Total Amount Hazardous Component Released: **42,025 pounds**

Notice the amount of Hydrochloric Acid release during the first hour compared to the Cyclohexylamine and the Acetone

ACETONE: Total Amount Released: 13,653 pounds
CYCLOHEXYLAMNE: Total Amount Released: 1,285 pounds
HYDROCHLORIC ACID: Total Amount Hazardous Component Released: 42,025 pounds

Notice ALOHA does not allow us to use the "tank" source model for any of the chemical "solutions". Thus, the amount of time needed for the Hydrochloric to exit the railcar is not considered by ALOHA. ALOHA modeled the Hydrochloric as if it were as instantaneously formed "puddle" that is 170 yards in diameter.

To effectively compare the volatization rate of the Acetone and the Cyclohexylamine to the Hydrochloric Acid, users would need to use the "puddle" model for all three materials. However, using the puddle model ignores the time necessary for the material to vacate the tanker via a 3" valve leak. Thus, the ALOHA results for the Acetone and the Cyclohexylamine will likely be more accurate using the Tank course model.

In any case, ALOHA provides additional information that may be critical to a safe and effective response to this derailment event. Incident Command should be appraised of the potential BLEVE area and the Toxic Threat Zone areas. The ERG-suggested Isolation Zone of 150 feet may not offer sufficient protective distances in this case.

Additionally, one should consider modeling all the above release scenarios using the forecasted weather. The fact that the temperature is going to be 55 degrees rather than 35 degrees may significantly alter the ALOHA Threat Zone predictions. And the wind direction and speed will be changing, too. Remember, no chemical release is occurring at 6:30 am, and we are using ALOHA to evaluate what might happen. As such, we should consider future weather conditions in our ALOHA analyses.

ANSWERS:

UN # 1789	Hydrochloric Acid, Solution
UN # 2428	Sodium Chlorate, Aqueous Solution
Acetone	Acetone
CAS # 108-91-8	Cyclohexylamine

CAMEO Chemicals

1. Use CAMEO Chemicals to gather information for the various chemicals. (CAMEO Companion pages 31-34)
    a. Are these materials liquid, solid, or gas? ***ALL ARE LIQUIDS***
    b. Is it likely that these materials are carried in Liquid Tankers or Pressurized Tankers? ***ALL WOULD LIKELY SHIP IN LIQUID TANKERS***
    c. What are the primary hazards associated with these materials?
    ACETONE: FLAMMABLE
    HYDROCHLORIC ACID: REACTIVE AND TOXIC
    CYCLOHEXYLAMINE: TOXIC AND FLAMMABLE
    SODIUM CHLORATE: OXIDIZER

2. Use the CAMEO Chemicals "Predict Reactivity" module to evaluate the potential reactive hazards for this incident. (CAMEO Companion pages 34-35)

	CYCLOHEXYLAMINE		
HYDROCHLORIC ACID, SOLUTION	Corrosive Heat generation Intense reaction Toxic gas	HYDROCHLORIC ACID, SOLUTION	
SODIUM CHLORATE, AQUEOUS SOLUTION	Corrosive Explosive Flammable Flammable gas Heat generation Toxic gas	Combustion-enhancing gas Corrosive Explosive Flammable Heat generation Intense reaction Toxic gas	SODIUM CHLORATE, AQUEOUS SOLUTION
ACETONE	Flammable gas	Heat generation	Explosive Flammable Heat generation Intense reaction Toxic Toxic gas

3. Determine the Initial Isolation Zone and Evacuation distances appropriate for this scenario. (CAMEO Companion pages 31-34) ***ERG SUGGESTS 150 IMMEDIATE ISOLATION ZONE FOR ALL FOUR OF THESE SUBSTANCES. EVACUATION DISTANCES VARYFROM 100 FEET TO 1000 FEET (NON-FIRE); AND ½ MILE (FIRE)***