



CalARP Offsite Consequence Analysis

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W-A1
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26th California Unified Program
Annual Training Conference
February 26-29, 2024

PSM / RMP / CalARP Components

- Registration.....(RMP/CalARP)
- Executive Summary.....(RMP/CalARP)
- Management System.....(RMP/CalARP)
- Hazard Assessment.....(RMP/CalARP)
- Prevention Program Elements.....(PSM/RMP/CalARP)
- Emergency Response Program.....(PSM/RMP/CalARP)



CalARP Hazard Assessment

- 5-Year Accident History
- Offsite Consequence Analysis (OCA)
 - Worst-case and alternative release scenarios
 - Offsite impacts to public and environment



CalARP Offsite Consequence Analysis

Agenda

- Applicability
- Parameters
- Worst-case and Alternative Scenarios
- Modeling Software and Examples
 - RMP*Comp, ALOHA and Marplot
 - Toxic gases, liquids and solids
 - Flammable substances

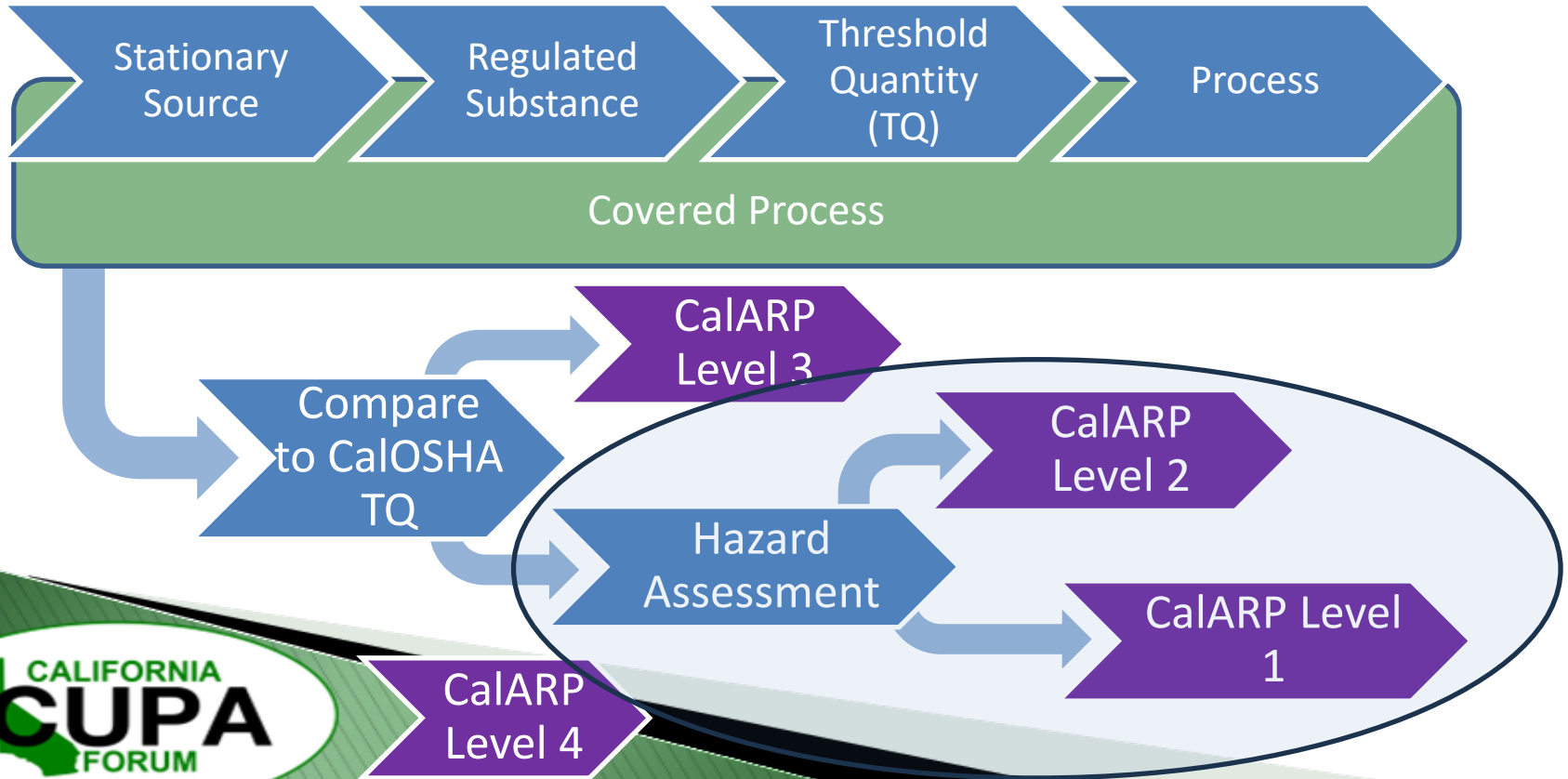


Poll Question 1

What would you like to learn most about in this session?



Applicability



Applicability

Program Level 1 (no offsite impacts)

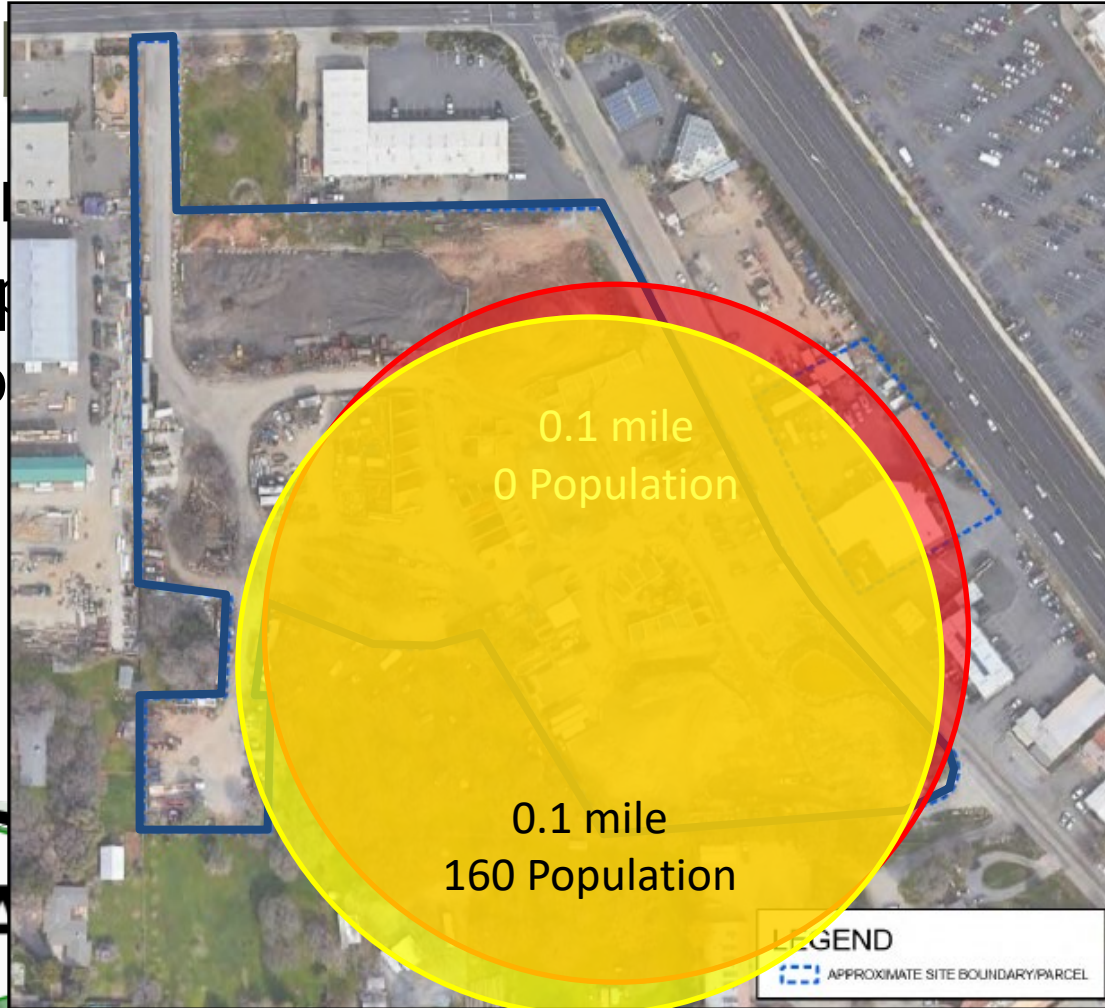
- Prepare one worst-case release scenario
- Report the 5-year accident history



Applica

Progr

- Prep
- Rep



Poll Question 2

Would this facility have offsite impacts with one or both worst-case releases?



Offsite Definition

19 CCR § 2735.3(rr)

“Offsite” means areas beyond the property boundary of the stationary source, and areas within the property boundary to which the public has routine and unrestricted access during or outside business hours.



Applicability

Program Level 2, 3 or 4

- Prepare at least one worst-case release scenario
 - Greatest distance to endpoint for substances
 - If different public receptors are affected for both flammable and toxic processes, report additional worst-case
- Prepare alternative release scenarios for each process for toxic substances
- Prepare one alternative release for flammables
- Report the 5-year accident history



Toxic Endpoints

Toxic Endpoints (listed in [Appendix A of CCR, Title 19, Division 2, Chapter 4.5](#))

Ammonia: 0.14 mg/L

Chlorine: 0.0087 mg/L

Nitric Acid: 0.026 mg/L

Sulfur Dioxide: 0.0078 mg/L

Paraquat dichloride: 0.0005 mg/L

Acrolein [2-Propenal]: 0.0011 mg/L



Toxic Endpoints

Ammonia mg/L to PPM conversion

$$\text{Endpoint (ppm)} = \frac{[\text{Endpoint (mg/L)} \times 1000 \times 24.5]}{[\text{Molecular Weight}]}$$

$$201 \text{ ppm} = \frac{(0.14 \text{ mg/L} \times 1000 \times 24.5)}{17.03}$$



Flammable Endpoints

- Overpressure of 1 pound per square inch (psi) for vapor cloud explosions.
- Radiant heat/exposure time. A radiant heat of 5 kw/m² for 40 seconds.
- Lower flammability limit. A lower flammability limit as provided in NFPA documents or other generally recognized sources.



Worst-case Release Parameters

Quantity released

- Greatest amount held in single vessel or pipe
- Administrative controls (procedures limiting quantity)

Weather conditions

- F atmospheric stability
- 1.5 meters/second wind speed
- Highest daily maximum temperature within 3 years (liquids)

Release height

- Ground level release (0 feet)



Worst-case Release Parameters

Duration of release

- 10 minutes for gases
- Instantaneous spill and volatilization for liquids and refrigerated gases handled as liquid
- One hour for toxic solids

Substance temperature

- Refrigerated liquids at boiling point
- Account for toxic liquid temperature in scenario



Worst-case Release Parameters

Passive mitigation must be able to withstand the release event and remain functional

- Building enclosure
- Containment dike

Surface Roughness

- Urban: Many obstacles in the immediate area
- Rural: Flat, unobstructed



Worst-case Release Parameters



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Poll Question 3

Would you select urban or rural surface roughness?



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Worst-case Release Selection

Stationary source with multiple processes or parameters:

- Assess worst-case scenario for the processes with the greatest quantity in a vessel or pipe
- Assess other scenarios with a higher pressure or temperature
- Assess additional scenarios closer the fence line.

Select the worst-case with the greatest distance to toxic endpoint beyond the stationary source boundary.



Alternative Release Parameters

Toxic Substances

- Analyze at least one alternative release scenario for each regulated substance

Flammable Substances

- One alternative to represent flammable substance processes.



Alternative Release Parameters

Scenario selection:

- More likely to occur than the worst-case scenario
- Reach an endpoint offsite, unless no such scenario exists
- Reach a public receptor, unless no such scenario exists

Factors in selecting the scenario:

- Five-year accident history
- Accidents / incidents in related industry
- Failure scenarios identified in the Hazard Review or Process Hazard Analysis



Alternative Release Parameters

Mitigation

- Active: Emergency shut down systems, transfer or deluge
- Passive: Building enclosure, containment berms,

Weather conditions

- Typical conditions may be used

Surface Roughness

- Urban: Many obstacles in the immediate area
- Rural: Flat, unobstructed



Offsite Impacts

Public

- Estimate the population with recent census data (2010 currently available in Marplot)
- 2 significant digits
- Note the presence of public institutions in the RMP

Public receptors:

- Schools, childcare facilities, hospitals, long term health care facilities, prisons, parks, recreational areas and major commercial, office or industrial buildings.



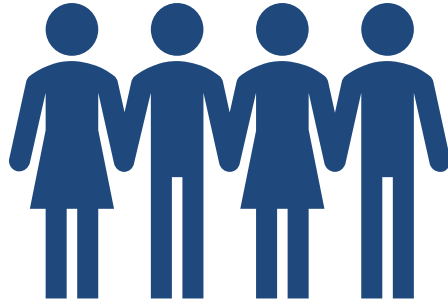
Definitions

19 CCR § 2735.3(ww)

“Population” means the public

19 CCR § 2735.3(eee)

“Public” means any person except employees or contractors at the stationary source.



Offsite Impacts

Environmental

- List environmental receptors within the distance to endpoint.

Environmental receptors:

- National or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, refuges, or areas; and Federal wilderness areas



Offsite Consequence Analysis Updates

Update Requirements

- Every five years, or
- When a process change increases or decreases the distance to toxic endpoint by a factor of 2 or more



Poll Question 4

What else is required if the worst-case distance to endpoint decreases by a factor of two or more?



Documentation

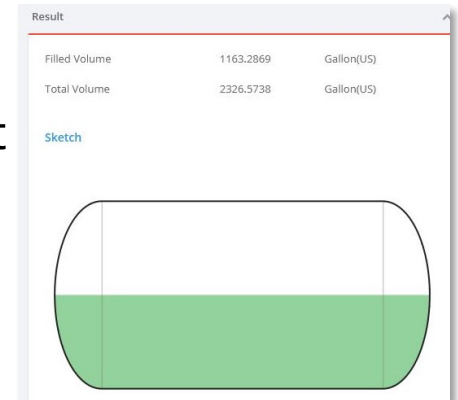
Worst-case and Alternative

- Description of scenario (vessel, pipe and substance)
- Assumptions, parameters used and rationale
 - Administrative controls and any passive mitigation
 - Effect of the controls and mitigation on the release quantity and rate

Estimate quantity released, release rate and duration

Methodology and model used for distance to endpoint

Data used for estimating public and environmental receptors

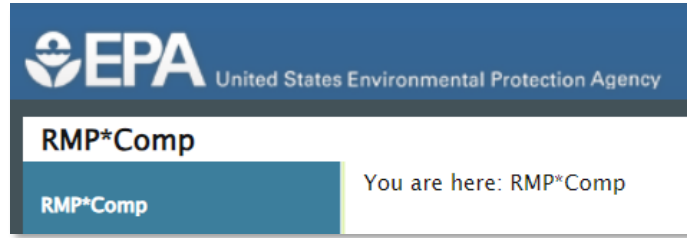


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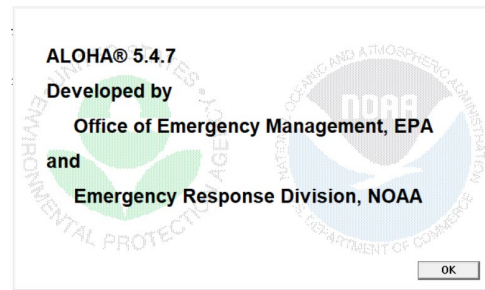


Examples

RMP*Comp



ALOHA

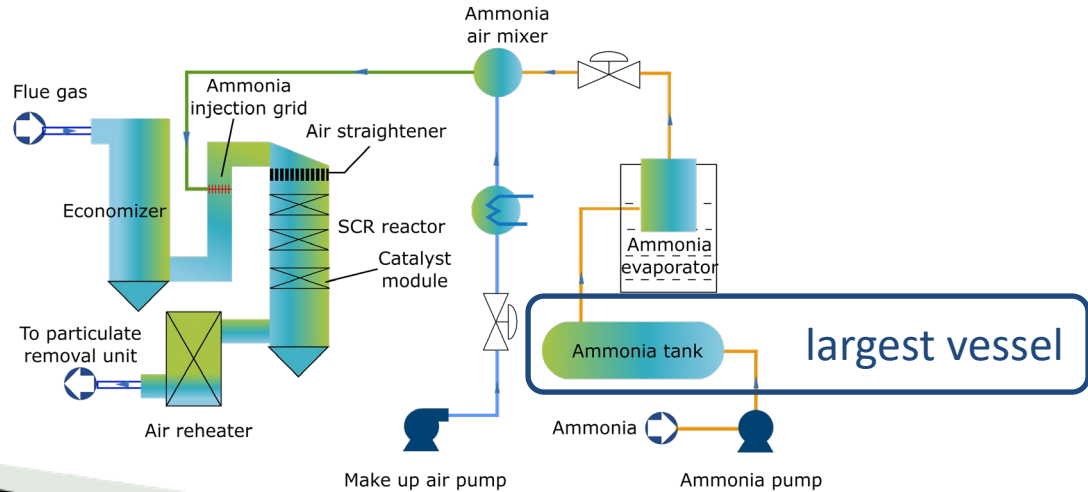


Marplot



Example 1

Worst-case release from a biomass plant with a selective catalytic reduction process that contains up to 51,000 pounds of ammonia.



Example 1

Worst-case release scenario

Quantity: 51,000 pounds contained within one storage vessel.

Physical state: Liquified under pressure

Terrain: Rural, open area with few obstructions

Mitigation: None, located outside



Example 1

Acetylene [Ethyne]	74-86-2	Flammable Gas
Acrolein	107-02-8	Toxic Liquid
Acrylonitrile	107-13-1	Toxic Liquid
Acrylyl chloride	814-68-6	Toxic Liquid
Allyl alcohol	107-18-6	Toxic Liquid
Allylamine	107-11-9	Toxic Liquid
Ammonia (anhydrous)	7664-41-7	Toxic Gas
Ammonia (water solution)	7664-41-7	Toxic Liquid
Arsenous trichloride	7784-34-1	Toxic Liquid
Arsine	7784-42-1	Toxic Gas
Boron trichloride	10294-34-5	Toxic Gas
Boron trifluoride	7637-07-2	Toxic Gas
Boron trifluoride compound with methyl ether (1:1)	353-42-4	Toxic Liquid



Example 1

Errors Found

No errors found

Chemical Information

Chemical Name: Ammonia (anhydrous)

CAS Number: 7664-41-7

Chemical Type: Toxic Gas

Worst-case Analysis

? Scenario type: Worst-case Alternative

? Physical state: Unliquefied
 Liquefied by refrigeration
 Liquefied under pressure

? Quantity released:

? Surrounding terrain type: Urban (many obstacles in the immediate area)
 Rural (terrain generally flat and unobstructed)

Mitigation measures

Check the checkbox below if the following mitigation measure is in place in your process.

? Release in enclosed space, in direct contact with
outside air:

Example 1

Estimated Distance Calculation

 Estimated distance to toxic endpoint: 4.0 miles (6.4 kilometers)

This is the downwind distance to the toxic endpoint specified for this regulated substance under the RMP Rule. Report all distances shorter than 0.1 mile as 0.1 mile, and all distances longer than 25 miles as 25 miles.

Same scenario in ALOHA is greater than 6 miles



Exam

Scenario Summary

Chemical: Ammonia (anhydrous)

CAS number: 7664-41-7

Threat type: Toxic Gas

Scenario type: Worst-case

Physical state: Liquefied under pressure

Quantity released: 51000 pounds

Release duration: 10 min

Release rate: 5100 pounds per minute

Mitigation measures: NONE

Surrounding terrain type: Rural surroundings (terrain generally flat and unobstructed)

Toxic endpoint: 0.14 mg/L; basis: ERPG-2

Assumptions about this scenario

Wind speed: 1.5 meters/second (3.4 miles/hour)

Stability class: F

Air temperature: 77 degrees F (25 degrees C)

Exam

Wind
↓

Selection Info
1 object selected (WC Example, 51,000 pounds, 4.0 miles, Examples)
Radius: 4.00 miles Area: 1401310908 sq feet

2010 U.S. Census Data
Population: 106,822
Housing units: 31,602

Click Point (📍): 37.638294°N, 120.982576°W USNG: 10S FG 78000 67598

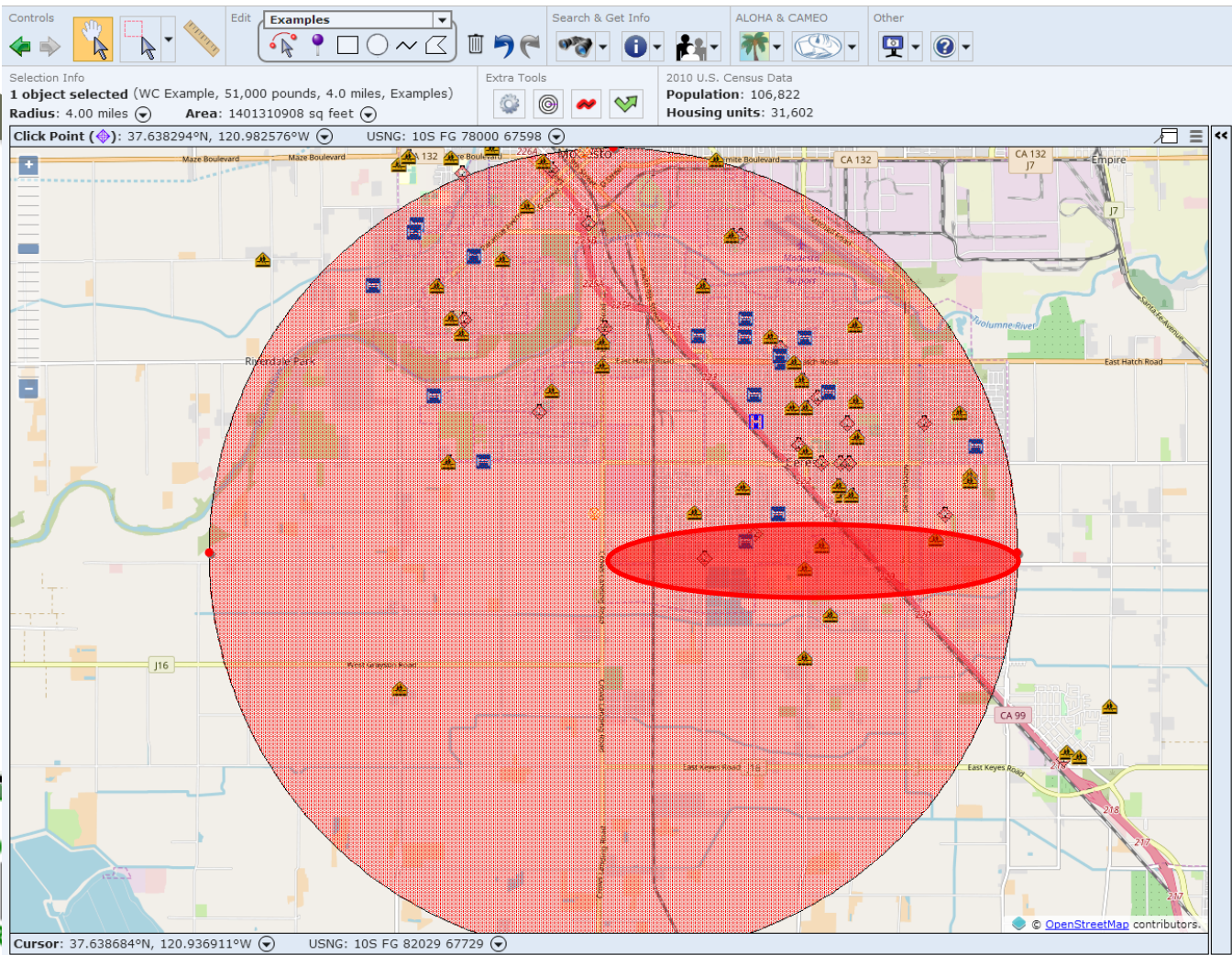
Cursor: 37.610422°N, 120.912538°W USNG: 10S FG 84249 64641



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Exam

Wind
↓



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/ 26-29, 2024

Example 1

Report the public receptor types with the distance to toxic endpoint.

2.13 Public receptors within distance to endpoint	
2.13.a. Schools	Y
2.13.b. Residences	Y
2.13.c. Hospitals	
2.13.d. Prison/Correctional Facilities	
2.13.e. Recreational Areas	Y

A list of public receptors is not required.

School	Lodi Academy	1230 S. Central Avenue	Lodi	CA
School	Lodi Seventh-Day Adventist Elementary	1240 S. Central Avenue	Lodi	CA
School	Clyde Needham Elementary School	420 S. Pleasant Avenue	Lodi	CA
School	Heritage Primary Elementary School	509 E. Eden Street	Lodi	CA



RMP*Comp

- Provides the distance to endpoint results from simple generalized calculations
- Follows Risk Management Program Guidance For Offsite Consequence Analysis
- Provides results in 0.1 mile increments up to 25 miles
- Weather conditions are not adjustable



Example 2

Worst-case release from a water treatment facility that stores up to 3,200 gallons of 19% aqueous ammonia. The storage tank is within a containment dike of 600 square feet.

The process contains approximately 4,700 pounds of ammonia. Model the instantaneous spill and volatilization.



Example 2 – RMP*Comp

Worst-case release scenario

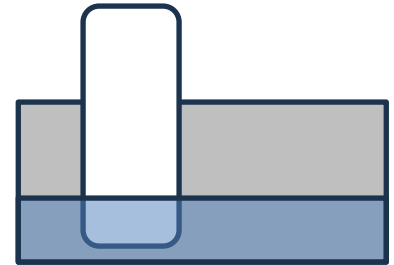
Quantity: 3,200 gallons of 20-percent aqueous ammonia in a storage tank.

Physical state: Liquid

Temperature of liquid: 109 °F

Terrain: Rural, open area with few obstructions.

Mitigation: None, located outside.



Example 2 – RMP*Comp

Errors Found

No errors found

Chemical Information

Chemical Name: Ammonia (water solution)

CAS Number: 7664-41-7

Chemical Type: Toxic Liquid

Worst-case Analysis

? Scenario type: Worst-case Alternative

? Initial concentration (weight percent): 20 ▾

? Liquid temperature: 109 ° Fahrenheit ▾

? Quantity released: 3200 gallons ▾

? Surrounding terrain type: Urban (many obstacles in the immediate area)
 Rural (terrain generally flat and unobstructed)

Mitigation measures

Check the checkbox below if the following mitigation measure is in place in your process.

? Release in enclosed space, in direct contact with outside air:

Example

Estimated Distance Calculation

Estimated distance to toxic endpoint: 1.2 miles (1.9 kilometers)

This is the downwind distance to the toxic endpoint specified for this regulated substance under the RMP Rule. Report all distances shorter than 0.1 mile as 0.1 mile, and all distances longer than 25 miles as 25 miles.

Scenario Summary

Chemical: Ammonia (water solution)

Initial concentration: 20 %

CAS number: 7664-41-7

Threat type: Toxic Liquid

Scenario type: Worst-case

Liquid temperature: 109 F

Quantity released: 3200 gallons

Release duration: 10 min

Release rate: 489 pounds per minute

Mitigation measures: NONE

Surrounding terrain type: Rural surroundings (terrain generally flat and unobstructed)

Toxic endpoint: 0.14 mg/L; basis: ERPG-2

Assumptions about this scenario

Wind speed: 1.5 meters/second (3.4 miles/hour)

Stability class: F

Air temperature: 77 degrees F (25 degrees C)

Example 2 – ALOHA

Worst-case release scenario

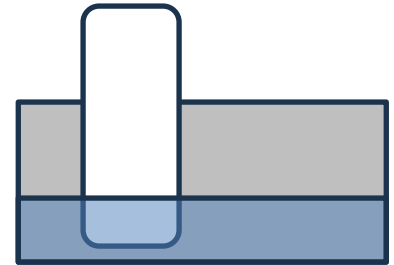
Quantity: 3,200 gallons of 19-percent aqueous ammonia in a storage tank

Physical state: Liquid

Air and liquid temperature: 109 °F

Terrain: Open country (Rural)

Mitigation: 600 square foot containment



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Example 2 - ALOHA

Chemical Information

View: Pure Chemicals
 Solutions

AQUEOUS AMMONIA
HYDROCHLORIC ACID
HYDROFLUORIC ACID
NITRIC ACID
OLEUM

Solution Strength: % (by Weight)

The percentage of ammonia in solution.
Allowable range is 0 to 30 percent.

Select
Cancel
Help





Example 2 - ALOHA

Atmospheric Options

Wind Speed is : knots mph meters/sec

Wind is from : Enter degrees true or text (e.g. ESE)

Measurement Height above ground is:




  OR enter value : feet meters

Ground Roughness is :

Open Country Urban or Forest OR Input Roughness (Z₀) :

Open Water

Select Cloud Cover :

OR enter value : (0 - 10)

complete cover partly cloudy clear



Example 2 - ALOHA

Atmospheric Options 2




Air Temperature is : Degrees F C

Stability Class is : A B C D E F

Inversion Height Options are :

No Inversion Inversion Present. Height is : feet meters

Select Humidity :

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



Example 2 - ALOHA

Puddle Input

Puddle area diameter is: square feet yards meters

Select one and enter appropriate data

Volume of puddle
 Average depth of puddle
 Mass of puddle

Volume is: gallons liters
 cubic feet cubic meters



Example 2 - ALOHA

Ground Type, Ground and Puddle Temperature

Select ground type Help

- Default soil (select this if unknown)
- Concrete
- Sandy dry soil
- Moist sandy soil
- Water (ALOHA does not model solutions on water)

Input ground temperature Help

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

Input initial puddle temperature Help

- Use ground temperature (select this if unknown)
- Use air temperature
- Initial puddle temperature is F C

OK Cancel

Example 2 - ALOHA

Toxic Level of Concern

Select Toxic Level of Concern:

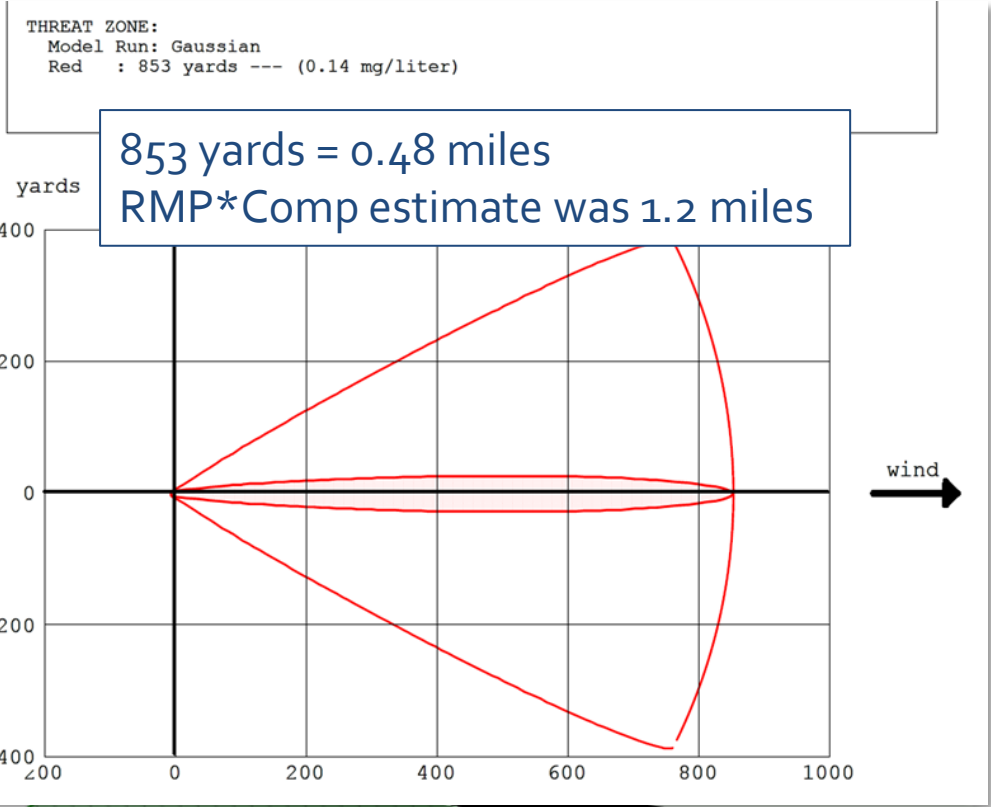
Red Threat Zone

LOC:

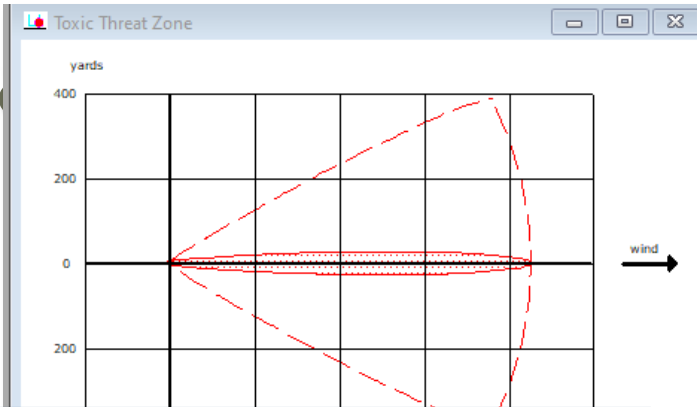
- ppm
- milligrams/cubic meter
- milligrams/liter
- grams/cubic meter



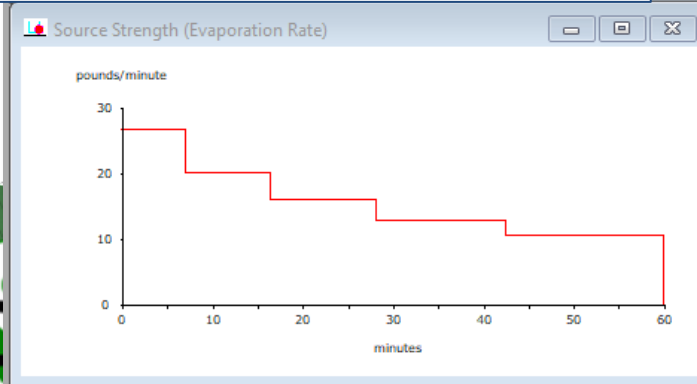
Example 2 - ALOHA



Ex



Release rate:
ALOHA 26.7 pounds/minute
RMP*Comp 489 pounds/minute



Text Summary

SITE DATA:
Location: MOUNTAIN HOUSE, CALIFORNIA
Building Air Exchanges Per Hour: 0.57 (unsheltered single storied)
Time: August 28, 2018 1410 hours PDT (user specified)

CHEMICAL DATA:
Chemical Name: AQUEOUS AMMONIA
Solution Strength: 19% (by weight)
Ambient Boiling Point: 121.2° F
Partial Pressure at Ambient Temperature: 0.70 atm
Ambient Saturation Concentration: 704,180 ppm or 70.4%
Hazardous Component: AMMONIA
CAS Number: 7664-41-7 Molecular Weight: 17.03 g/mol
AEGL-1 (60 min): 30 ppm AEGL-2 (60 min): 160 ppm AEGL-3 (60 min): 11
IDLH: 300 ppm LEL: 150000 ppm UEL: 280000 ppm

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 1.5 meters/second from w at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 109° F
Stability Class: F (user override)
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Evaporating Puddle (Note: chemical is flammable)
Puddle Area: 600 square feet Puddle Volume: 3200 gallons
Ground Type: Concrete Ground Temperature: 109° F
Initial Puddle Temperature: 104° F
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 26.7 pounds/min
(averaged over a minute or more)
Total Amount Hazardous Component Released: 941 pounds

THREAT ZONE:
Model Run: Gaussian
Red : 853 yards --- (0.14 mg/liter)

gram
nce

ALOHA

Allows for greater detail than RMP*Comp

- Weather conditions are editable
- Substance and containment release details
- Models a changing release rate over time
- Maximum distance is 6 miles



Example 3

Alternative release of chlorine from a 5/16" (0.3125) diameter hole at 150 psig assumed 25 °C tank temperature.

$$QR = HA \times Pt \times \frac{1}{\sqrt{T_t}} \times GF$$

where:	QR	=	Release rate (pounds per minute)
	HA	=	Hole or puncture area (square inches) (from hazard evaluation or best estimate)
	P_t	=	Tank pressure (pounds per square inch absolute (psia)) (from process information; for liquefied gases, equilibrium vapor pressure at 25 °C is included in Exhibit B-1, Appendix B)
	T_t	=	Tank temperature (K), where K is absolute temperature in kelvins; 25 °C (77 °F) is 298 K
	GF	=	Gas Factor, incorporating discharge coefficient, ratio of specific heats, molecular weight, and conversion factors (listed for each regulated toxic gas in Exhibit B-1, Appendix B)

Example 3

Alternative release of chlorine from a 5/16" (0.3125) diameter hole at 150 psig assumed 25 °C tank temperature.

$$QR = HA \times Pt \times \frac{1}{\sqrt{T_t}} \times GF$$

$$6.64 \frac{\text{lbs}}{\text{minute}} = 0.024 \times 164.7 \times \frac{1}{\sqrt{298}} \times 29$$

$$399 \text{ pounds} = 6.65 \text{ lbs./minute} \times 60 \text{ minutes}$$



Example 3

Exhibit 5
Chemical-Specific Reference Tables of Distances for Alternative Scenarios

Substance	Conditions of Release			Reference Table Number
	Gas or Vapor Density	Release Duration (minutes)	Topography	
Chlorine	Dense	10-60	Rural, urban	24

Reference Table 24
Distances to Toxic Endpoint for Chlorine
D Stability, Wind Speed 3.0 Meters per Second

Release Rate (lbs/min)	Distance to Endpoint (miles)	
	Rural	Urban
1	<0.1*	<0.1*
2	0.1	
5	0.1	0.1
10	0.2	



Poll Question 5

Have you reviewed or prepared worst-case releases for toxic solids?



Example 4

Worst-case scenario for toxic solids

5-pound bag of 70-percent phosmet pesticide (Imidan 70-W)

EPA emission factor 20 pounds/ton (1-percent) for industrial pigment mixing from weighing, mixing, grinding, tinting, thinning, and packaging.

Bag falls off a shelf and forms a 0.2672 ft³ pile.



Example 4

Release from largest container based on emission factor

$$QR = EF \times (LC \times CS) \times M$$

QR = Quantity Released

EF = Emission Factor

LC = Largest Container

CS = Concentration of Substance

M = Mitigation Release Inside Building

$$0.01925 \text{ pounds} = 0.01 \times (5 \text{ pounds} \times 0.70\text{-percent}) \times 0.55$$



Example 4

Use Screen3 for dispersion modeling to find distance to endpoint

The screenshot shows the 'Screen3 for Windows [New]' application window. The menu bar includes 'File', 'Edit', 'Windows', and 'Help'. The toolbar contains icons for file operations and help. The main interface is titled 'Input Data' and has three tabs: 'Options', 'Source', and 'Receptors'. The 'Options' tab is active, showing a 'Title' field and several configuration sections: 'Source Type' (Point, Flare, Area, Volume), 'Terrain Options' (Flat, Simple Elevated, Complex), 'Fumigation' (Inversion Break-up, Shoreline), 'Rural/Urban' (Rural, Urban), 'Stability/Wind Speed' (All Stab. & WS, Single Stability, User Stab & WS), 'Temperature' (Ambient Temperature in K and F), 'Mixing Heights' (Regulatory, Brode Values), and 'Anemometer' (Height in ft and m). A small 3D landscape icon is visible in the bottom left of the input data area.

Section	Option	Value
Source Type	Volume	Selected
Terrain Options	Flat	Checked
Stability/Wind Speed	Stability	F
Stability/Wind Speed	Wind Speed (miles/hr)	3.3554
Stability/Wind Speed	Wind Speed (m/s)	1.5000
Temperature	Ambient Temperature (°K)	[Empty]
Temperature	Ambient Temperature (°F)	[Empty]
Mixing Heights	Regulatory	Selected
Anemometer	Height (ft)	32.8084
Anemometer	Height (m)	10.0000



Example 4

Screen3 for Windows [New]

File Edit Windows Help

Input Data

Options | Source | Receptors

Volume Source

	English	Metric
Emission Rate:	0.019254 (lb/hr)	0.002426 (g/s)
Release Height:	0.0000 (ft)	0.0000 (m)
Initial Horz. Dim.:	4.0000 (ft)	1.2192 (m)
Initial Vert. Dim.:	0.0167 (ft)	0.0051 (m)

Building

Height:		(ft)		(m)
Length:		(ft)		(m)

Cavity

- Regulatory Default
- Schulman-Scire -- Stack not on structure
- Schulman-Scire -- Stack on structure


Print values for all wind speeds

Ratio of distance of stack from the center of structure to side length

D/L for long side:

D/L for short side:

Example: $D/L \text{ (long)} = 35/100 = 0.35$
 $D/L \text{ (short)} = 15/50 = 0.30$



Example 4

Use Screen3 for dispersion modeling to find distance to endpoint

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	0.000	0	0.0	0.0	0.0	0.00	0.00	0.00	
10.	901.0	6	1.5	1.5	10000.0	0.00	1.61	0.36	NO
11.	813.0	6	1.5	1.5	10000.0	0.00	1.65	0.38	NO
12.	739.1	6	1.5	1.5	10000.0	0.00	1.69	0.41	NO
13.	676.2	6	1.5	1.5	10000.0	0.00	1.73	0.44	NO
14.	622.0	6	1.5	1.5	10000.0	0.00	1.77	0.47	NO
15.	574.9	6	1.5	1.5	10000.0	0.00	1.81	0.49	NO
16.	533.5	6	1.5	1.5	10000.0	0.00	1.85	0.52	NO
17.	493.0	6	1.5	1.5	10000.0	0.00	1.89	0.55	NO
18.	455.4	6	1.5	1.5	10000.0	0.00	1.93	0.57	NO
19.	420.0	6	1.5	1.5	10000.0	0.00	1.97	0.60	NO
20.	409.2	6	1.5	1.5	10000.0	0.00	2.01	0.63	NO
30.	245.5	6	1.5	1.5	10000.0	0.00	2.41	0.87	NO
40.	167.0	6	1.5	1.5	10000.0	0.00	2.80	1.10	NO
50.	122.3	6	1.5	1.5	10000.0	0.00	3.19	1.32	NO
60.	94.09	6	1.5	1.5	10000.0	0.00	3.57	1.53	NO
70.	74.99	6	1.5	1.5	10000.0	0.00	3.95	1.74	NO
80.	61.39	6	1.5	1.5	10000.0	0.00	4.33	1.94	NO
90.	51.33	6	1.5	1.5	10000.0	0.00	4.70	2.13	NO
100.	43.65	6	1.5	1.5	10000.0	0.00	5.07	2.33	NO

Phosmet toxic endpoint 0.00054 mg/l



Example 4

Worst-case release without known emission factor.

$$\text{ARF} = \frac{0.1064 \times (M_O^{0.125}) \times (H^{2.37})}{P_{BP}}$$

ARF = airborne release fraction

M_O = mass of powder spilled (kg)

H = Spill height (m)

P_{BP} = bulk density of powder (kg/m³)

Source:

[DOE-HDBK-3010-94](#)

[4.4.3.1.3 Free-Fall Spill of Powder Model 4-81](#)

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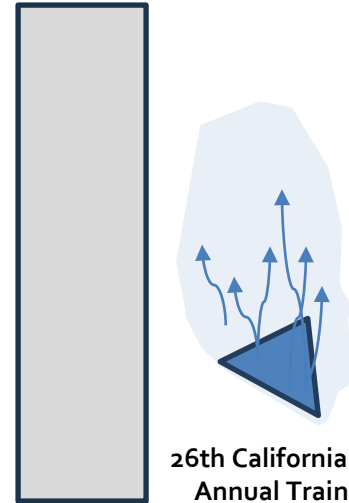
Example 4

5-pound bag of Imidan 70-W with a density of 240 kg/m³ falls from a 1.5-meter-high shelf.

$$\text{ARF} = \frac{0.1064 \times (M_O^{0.125} \times H^{2.37})}{P_{BP}^{1.02}}$$

$$0.001151 = \frac{0.1064 (2.27^{0.125} \times 1.5^{2.37})}{240^{1.02}}$$

$$0.001151 = \frac{0.1064 (1.17 \times 2.61)}{267.8}$$



Example 4

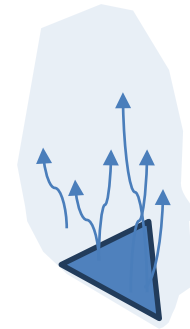
Release based on calculated airborne release fraction

$$QR = ARF \times (LC \times CS) \times M$$

$$0.002215 = 0.001151 \times (5\text{-pounds} \times 0.70) \times 0.55$$

$$0.002215 \text{ pounds}/60 \text{ minutes}$$

$$= 3.69 \times 10^{-5} \text{ pounds}/\text{minute}$$



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Example 4

Toxic endpoint of 0.00054 mg/l

Release rate 3.69×10^{-5} pounds/minute

Exhibit 3-1
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

SCREENING - Rural, F Atmospheric Stability, Low Wind Speed (3.4 miles per hour), Distances are Given in Miles

For Quantities of Release up to 10,000 pounds/minute

QR Rate of Release (#/min)	Levels of Concern (grams per cubic meter)																					
	(For LOC less than this, assume 10 mile distance)								0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
	0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005															
1	9.0	2.5	1.7	1.3	0.9	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	
2	*	1.5	2.8	2.1	1.3	0.9	0.8	0.6	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	**	**	**
3	*	6.7	3.9	2.9	1.7	1.2	1.0	0.8	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**
4	*	9.0	5.1	3.7	2.1	1.5	1.2	0.9	0.8	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**
5	*	*	6.3	4.5	2.5	1.7	1.3	1.0	0.9	0.6	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**
8	*	*	*	7.1	3.7	2.4	1.8	1.4	1.2	0.8	0.5	0.4	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**
10	*	*	*	9.0	4.5	2.8	2.1	1.6	1.3	0.9	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**
15	*	*	*	*	6.7	3.9	2.9	2.1	1.7	1.1	0.8	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**
20	*	*	*	*	9.0	5.1	3.7	2.7	2.1	1.3	0.9	0.8	0.6	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**
25	*	*	*	*	*	6.3	4.5	3.2	2.5	1.5	1.1	0.9	0.7	0.6	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**
30	*	*	*	*	*	7.6	5.3	3.7	2.9	1.7	1.2	1.0	0.8	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1
35	*	*	*	*	*	*	9.0	6.2	4.2	3.3	2.0	1.3	1.1	0.8	0.7	0.4	0.3	0.2	0.2	0.1	0.1	0.1
40	*	*	*	*	*	*	*	7.1	4.8	3.7	2.1	1.5	1.2	0.9	0.8	0.4	0.3	0.2	0.2	0.1	0.1	0.1
45	*	*	*	*	*	*	*	8.0	5.3	4.1	2.3	1.6	1.2	1.0	0.8	0.5	0.3	0.3	0.2	0.2	0.1	0.1
50	*	*	*	*	*	*	9.0	5.9	4.5	2.5	1.7	1.3	1.0	0.9	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1
60	*	*	*	*	*	*	*	7.1	5.3	2.9	1.9	1.5	1.2	1.0	0.6	0.4	0.3	0.3	0.2	0.1	0.1	0.1

Example 4

2.5-mile distance to toxic endpoint at 1 pound/minute from Exhibit 3-1

Vast overestimate of with release rate increased to 1 pound/minute from 3.69×10^{-5} pounds/minute.

Air modeling for solids takes more effort than other substance types. Worst-case releases of solids typically don't result in offsite impacts.



Example 5

Worst-case flammable release

50,000 pounds of propane liquefied under pressure

RMP*Comp

[← Back](#)

Errors Found

No errors found

Chemical Information

Chemical Name: Propane
CAS Number: 74-98-6
Chemical Type: Flammable Gas

Worst-case Analysis

Scenario type: Worst-case Alternative

Physical state: Unliquefied
 Liquefied by refrigeration
 Liquefied under pressure


Quantity released:



Example 5

50,000 pounds of propane liquefied under pressure

Estimated Distance Calculation

 Estimated distance to 1 psi overpressure: 0.3 miles (0.5 kilometers)

This is the distance to the overpressure endpoint of 1 pound per square inch specified for this regulated substance under the RMP Rule.

Scenario Summary

Chemical: Propane
CAS number: 74-98-6
Threat type: Flammable Gas
Scenario type: Worst-case
Physical state: Liquefied under pressure
Quantity released: 50000 pounds

Questions?



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Thank you

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