Appendix C – Transportation Release Analysis Details

This Appendix summarizes the main assumptions and methods that Petitioners, with the support of confidential consult experts, used to develop the figures presented at Part IV of the petition.

Contents

Figures

I. HF railcar and cargo truck routing; derailment and crash location assumptions

A. Railcar routing

Petitioners used commercial rail-routing software (PC*Miler Rail version 3.0.19.0) to determine the recommended (practical) rail routes their transportation scenarios are based on. PC*Miler defines practical rail routes as those that "simulate the most likely movements of general merchandise train traffic. Main lines are preferred to branch lines. A Practical route can sometimes be more circuitous than the shortest possible route."[1] The following screenshots show the routes.

[1] *See* PC*Miler, *Route Options for Single Rail Routes* (Oct. 25, 2018) https://support.pcmiler.com/en/support/solutions/articles/19000084917-route-options-for-single-rail-routes.

Figure 1: Practical rail route from Geismar, Louisiana to Joliet, Illinois

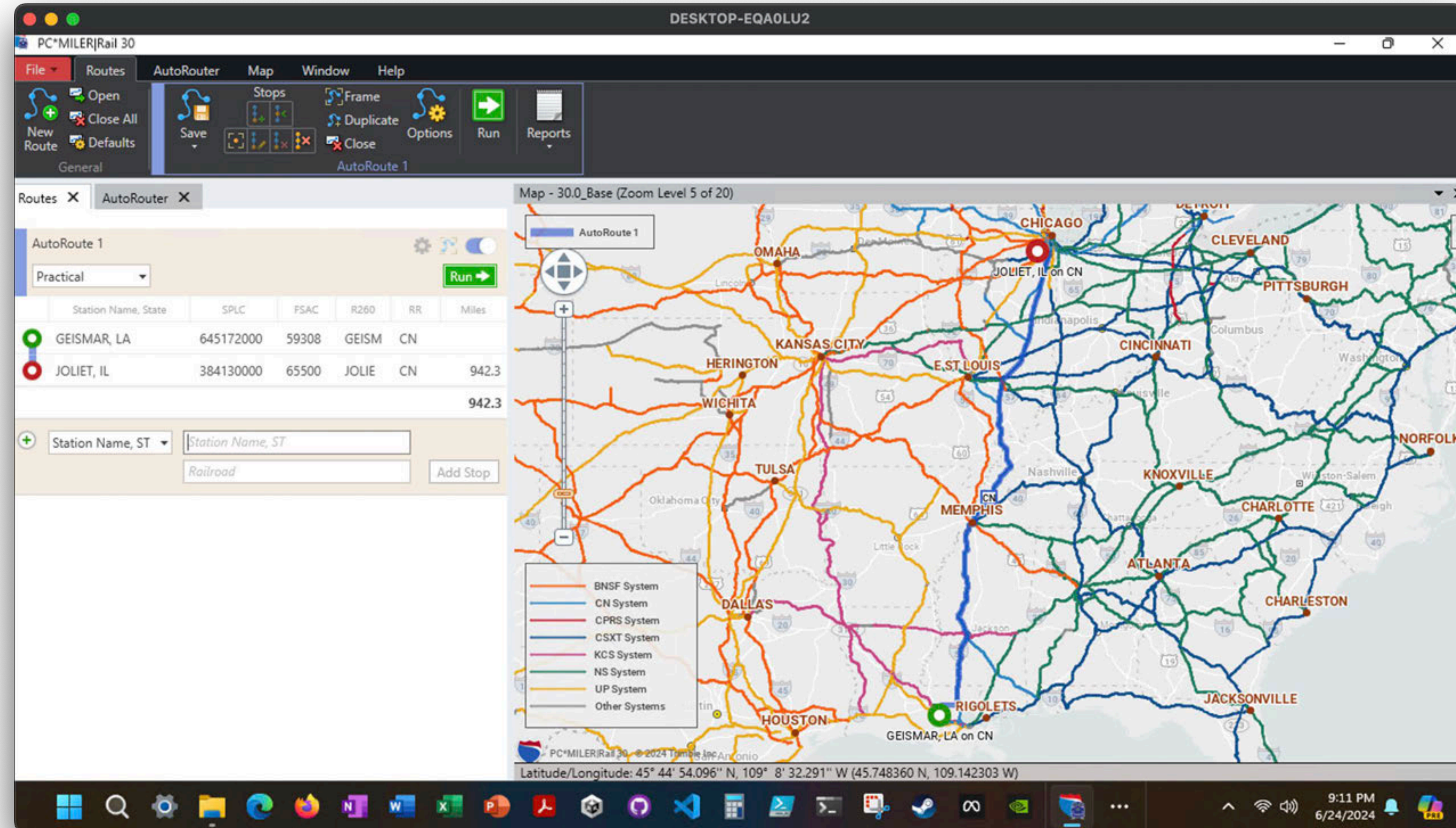


Figure 2: Practical rail route from Geismar, Louisiana to Joliet, Illinois – Memphis detail

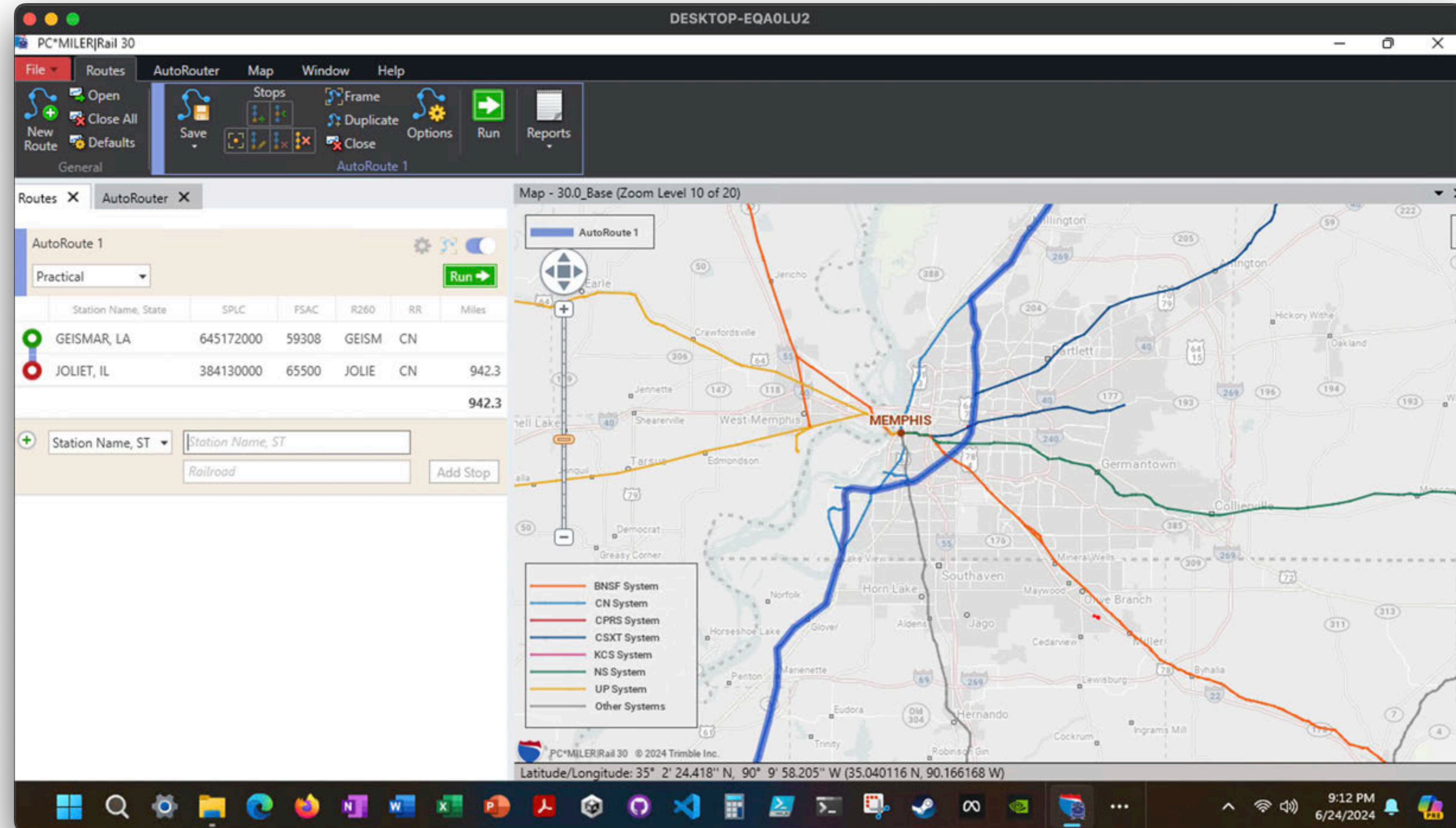


Figure 3: **Practical rail route from Geismar, Louisiana to Lemont, Illinois**

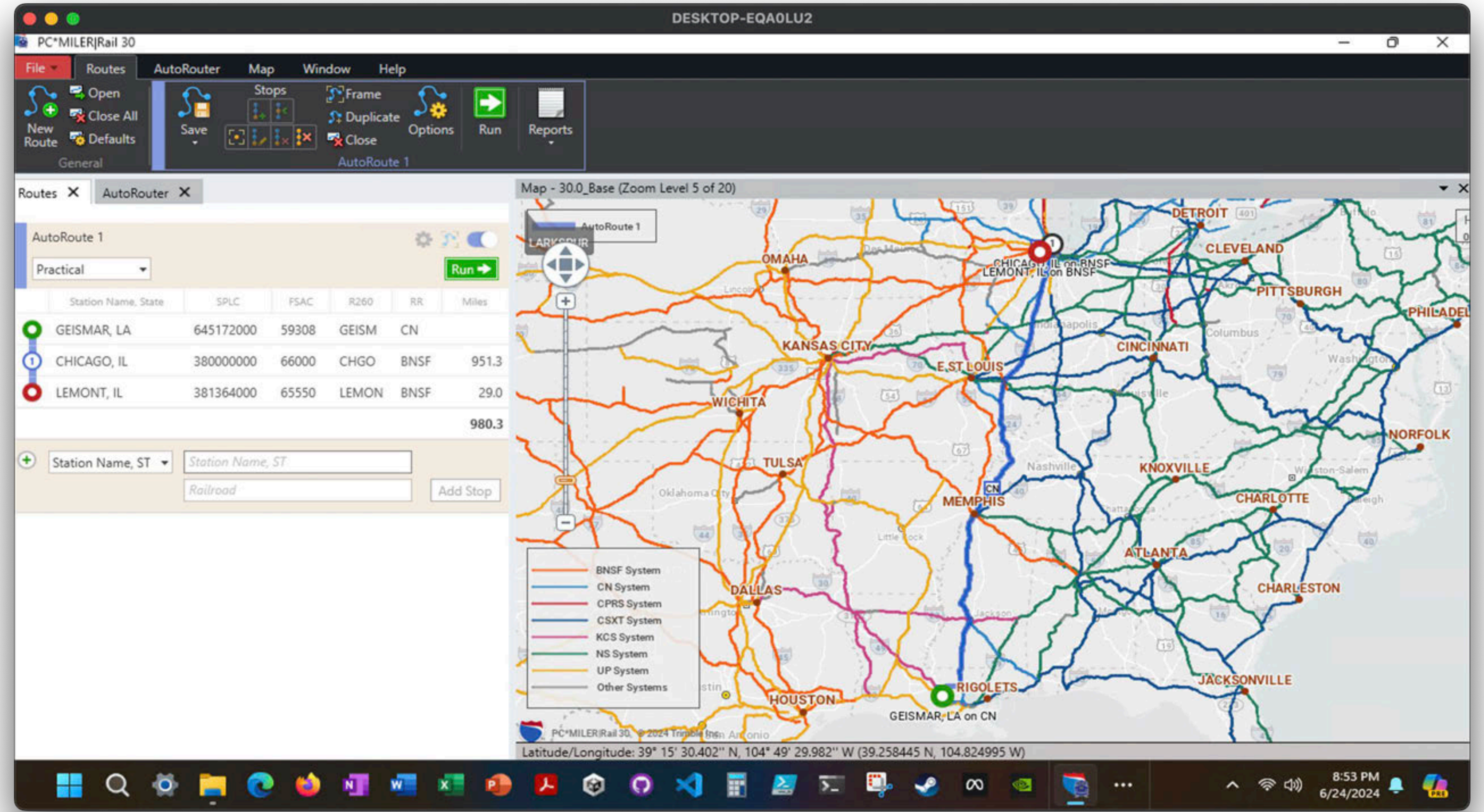


Figure 4: Practical rail route from Geismar, Louisiana to Trainer, Pennsylvania

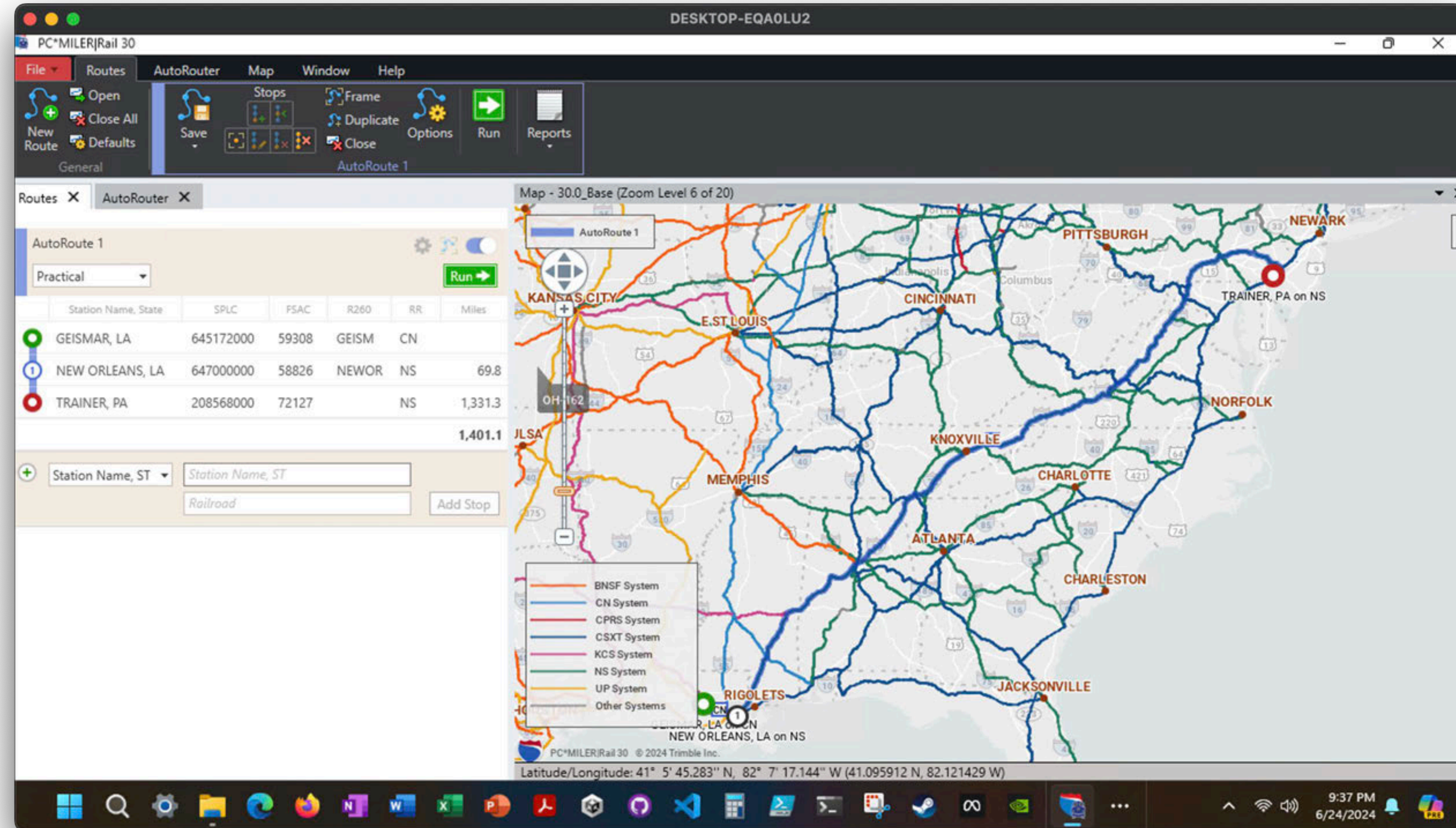
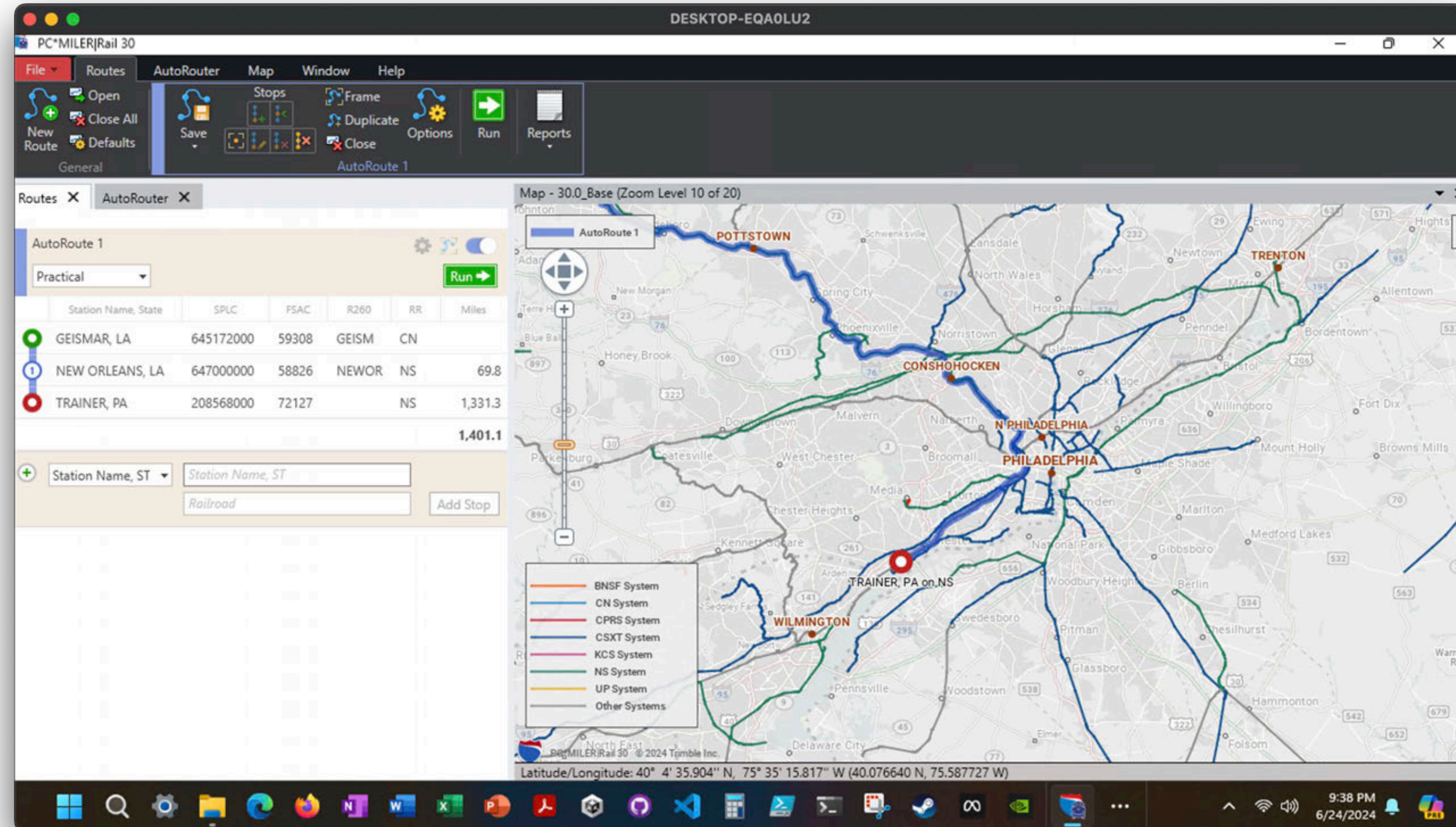


Figure 5: Practical rail route from Geismar, Louisiana to Trainer, Pennsylvania – Philadelphia detail



B. Truck routing

Petitioners used ArcGIS Pro software[2] with the ArcGIS Network Analyst extension[3] to develop the recommended cargo truck routes used in their truck crash scenarios. Petitioners applied constraints including Hazmat Prohibited, Truck Prohibited, Use Preferred Hazmat Routes (Priority), and Use Preferred Truck Routes.

The recommended routes (which pass through Baton Rouge, as well as the labeled cities) are shown below. The drive from Geismar to Torrance is approximately1,890 miles long and estimated to take 28 hours of driving time. The drive from Geismar to Wilmington is approximately 1,888 miles long and estimated to take 27 hours of driving time.

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[2] *See* Esri, *ArcGIS Pro*, https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview (visited Jan. 31, 2025).
[3] *See* Esri, *ArcGIS Network Analyst*, https://www.esri.com/en-us/arcgis/products/arcgis-network-analyst/features?srsltid=AfmBOoqDypiHE5Bb9N7PtU-9Qb0azpbM2hUtfaQ7gwvCdvpHg2b_ze-L (visited Jan. 31, 2025).

Figure 6: Overview of recommended cargo truck routes from Geismar, Louisiana to Torrance and Wilmington, California

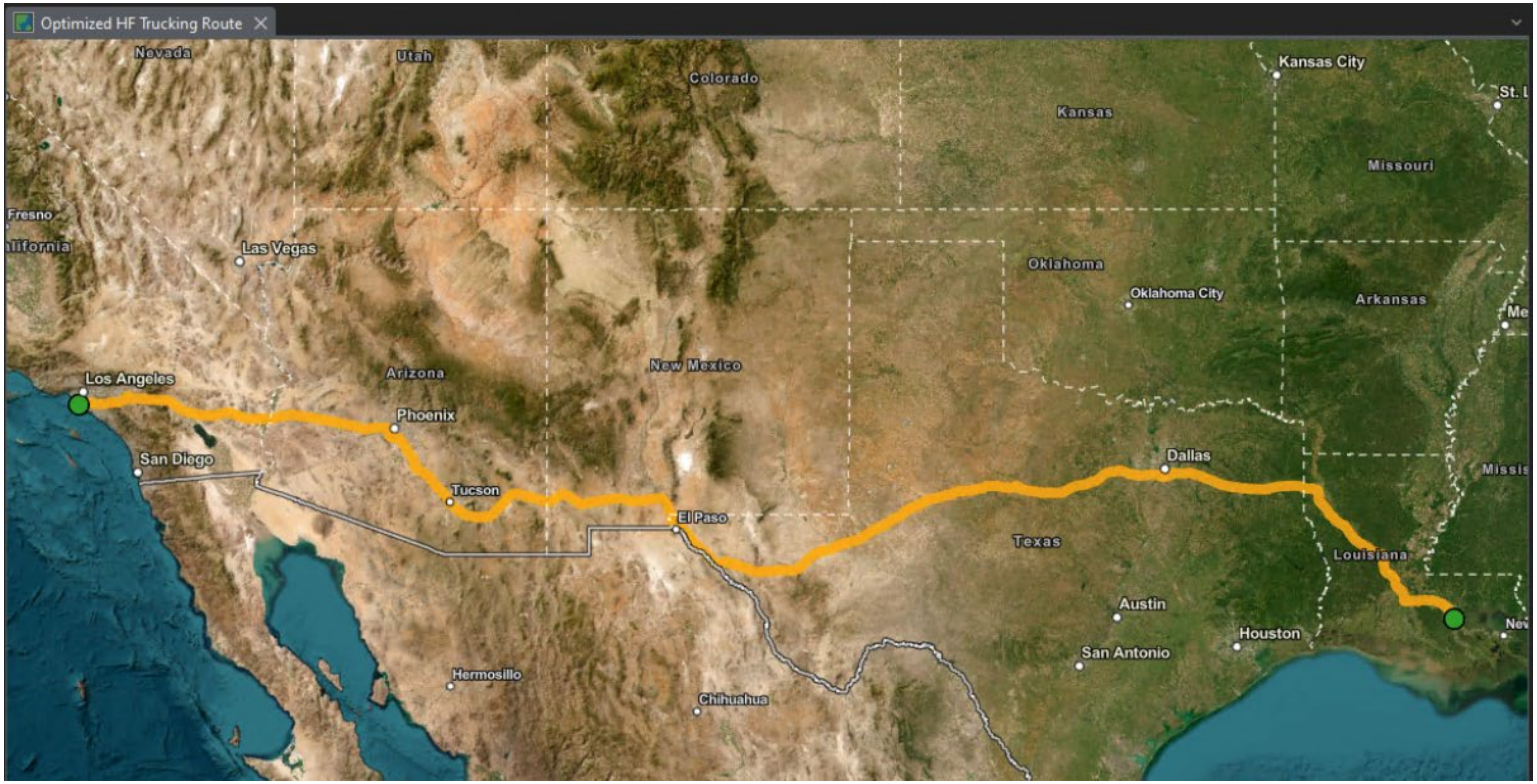
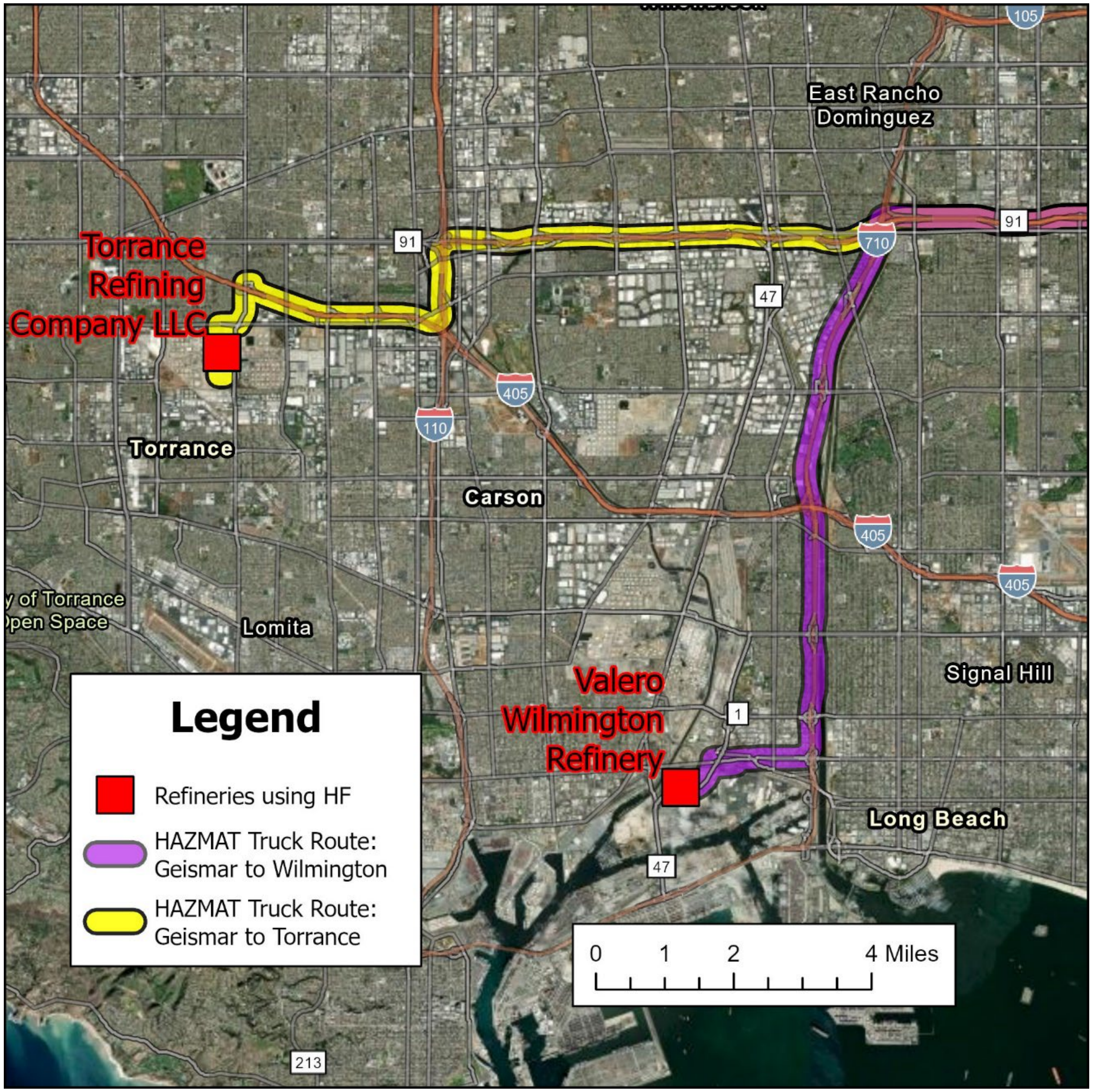


Figure 7: Recommended truck route from Geismar, Louisiana to Torrance and Wilmington California—Los Angeles area detail



C. Derailment and crash locations

Petitioners assumed the derailments and truck crashes used in their transportation scenarios would occur at relatively busy locations along the recommended rail and truck routes described at Parts I.[4]

The following figures, drawn from Google Maps,[5] and Google Earth[6] provide more detail on the intersections used as the basis for Philadelphia and Memphis derailment scenarios, and the Baton Rouge, Louisiana and Phoenix, Arizona truck crash scenarios.

Figure 8: Philadelphia derailment scenario location detail

[4] To help select their locations, Petitioners consulted the U.S. Department of Transportation's national Highway-Rail Grade Crossing Incidents database, available at Highway-Rail Crossing Incidents - Landing Page (last visited Jan. 31, 2025); an ArcGIS dataset on fatal highway crashes on Arizona roads, based on Arizona Department of Transportation data for the years 2019-2023 (last visited Jan. 31, 2025); and the University of California, Berkeley's Transportation Injury Mapping System database, available at https://tims.berkeley.edu (last visited Jan. 31, 2025).

[5] Google Maps, https://www.google.com/maps/ (last visited Jan. 31, 2025).

[6] Google Earth, https://earth.google.com/, (last visited Jan. 31, 2025).

Figure 9: Memphis derailment scenario location detail

Figure 10: Baton Rouge truck crash scenario location detail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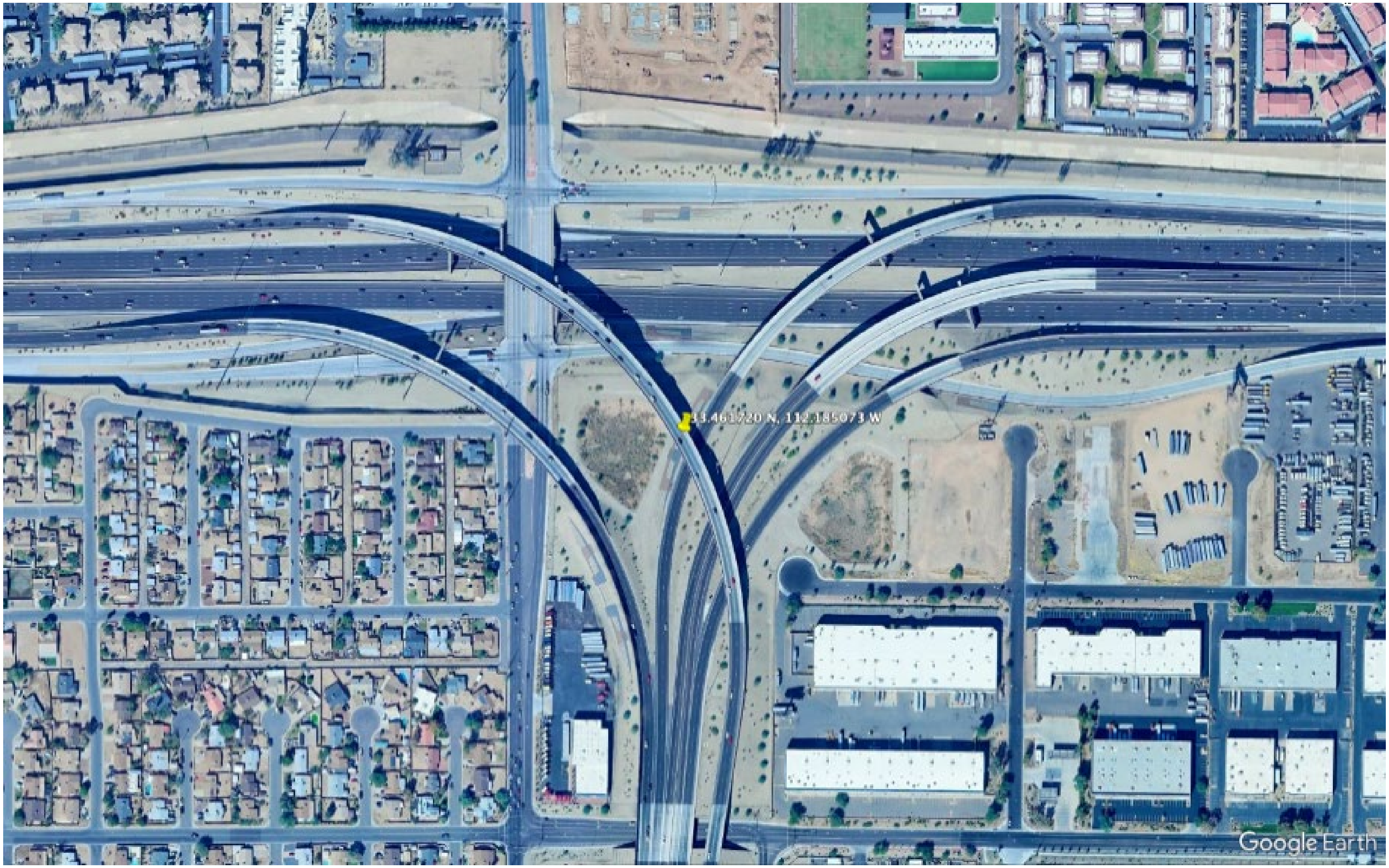
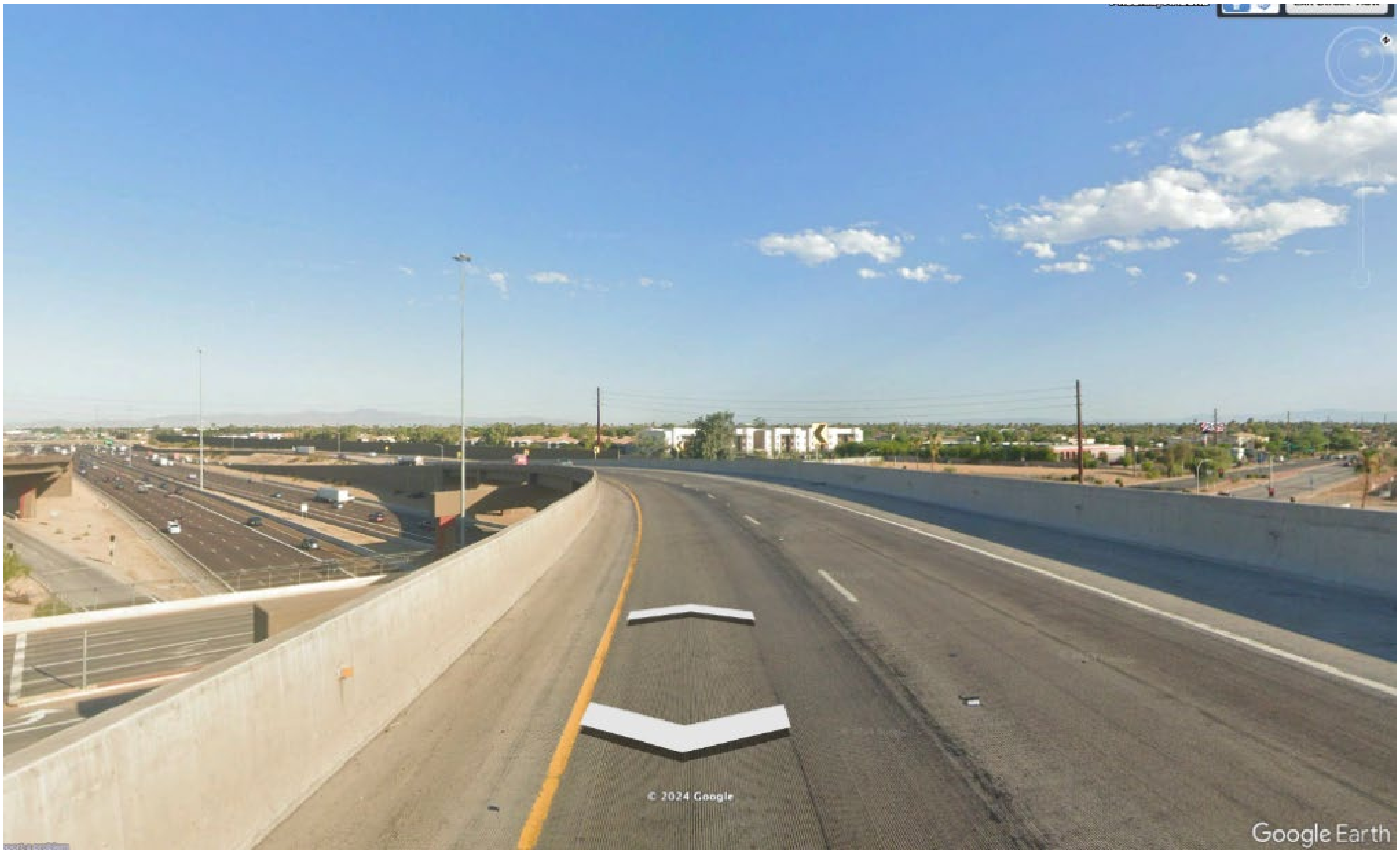
Google Earth

Figure 11: Phoenix truck crash scenario location detail




© 2024 Google
Google Earth

II. ALOHA modeling inputs and assumptions

A. Railcar release inputs

1. Rail tank car design and contents

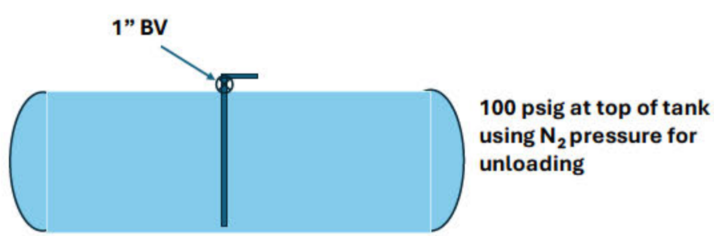
All of Petitioners' railcar release cases assume the following:

- Anhydrous HF (AHF) is transported in a 22,800 gallon rail tank car.
- The tank is about 9.75 feet in diameter and 40.9 feet long.
- The tank is designed to be unloaded through a 1-inch diameter liquid standpipe ending in a 90-degree elbow and controlled by a ball valve.
- At the time of the release, the tank car is holding 78,300 kilograms of liquid anhydrous HF, at a temperature of 38°C (100°F).

These estimates are based on Petitioners' analysis of information on the rail cars currently used by Honeywell, Inc. (the sole identified U.S. manufacturer of anhydrous HF for refinery use).

2. Rail tank car unloading conditions

For their unloading release case, Petitioners assumed the release would occur at the top of the tank, approximately 15 feet off the ground (accounting for the railcar's undercarriage), where the 1" liquid unloading line emerges from protective housing and connects to flexible hose. Petitioners assumed that the railcar would be pressurized with nitrogen for unloading—resulting in an assumed pressure of 100 pounds per square inch gauge (psig) at the top of tank.



Petitioners derived the following release parameters.

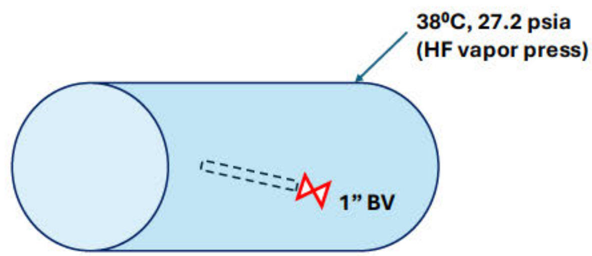
Figure 12: Railcar unloading release parameters – Trainer, Pennsylvania

AHF Railcar liquid content temp	**38ºC**
Time from onset of initial release	0 hr
Pressure at railcar head space (pounds per square inch absolute)	114.7 psia
Pressure atmospheric (pounds per square inch absolute)	14.7 psia
Initial discharge rate (kilograms per second)	8.62 kg/s
Vapor mass fraction - at exit plane	0.0
Vapor mass fraction - atmospheric jet prior to air entrainment	0.127
Exit-plane pressure (pounds per square inch absolute)	27.24 psia
Exit-plane temperature (degrees Celsius)	38ºC
Two-phase density - at exit plane (kilograms per cubic meter)	908 kg/m^3
Two-phase jet density - atmospheric jet prior to air entrainment (kilograms per cubic meter)	23.79 kg/m^3
Two-phase jet velocity - release from opening (meters per second)	17.02 m/s
Two-phase jet velocity after depressurization to atmosphere (meters per second)	22.61 m/s
Two-phase jet temperature (degrees Celsius)	19.6ºC
Two-phase jet area – atmospheric (square millimeters)	16025 mm^2
Approximate opening elevation (feet above ground)	15 feet

Petitioners assumed the tank car would be standing in the Trainer refinery's railcar unloading area, at 39.819663 latitude, -75.405222 longitude, at the time of the release.

3. Rail tank car derailment conditions

Petitioners assumed a derailment would cause the tank car to roll onto its side (tilt 90 degrees) and the standpipe ball valve to open. Because the tank car would still be enroute to the refinery, they did not assume any nitrogen pressurization—resulting in a vapor pressure of 27.2 pounds per square inch area (psia) in the head space at the top of the tank.



Petitioners used these assumptions to derive the following release parameters.

Figure 13: Railcar derailment release parameters – Philadelphia, Pennsylvania and Memphis, Tennessee

Railcar AHF liquid fill fraction	**100%**	**90%**	**80%**	**70%**	**60%**	**50%**
AHF liquid fill temperature	38ºC	37.92ºC	37.84ºC	37.76ºC	37.68ºC	37.6ºC
Time from onset of initial release	0 hr	1.83 hr	3.89 hr	6.13 hr	8.54 hr	11.13 hr
Pressure at railcar head space (pounds per square inch absolute)	29.16 psia	28.49 psia	28.05 psia	27.64 psia	27.26 psia	26.89 psia
Pressure atmospheric (pounds per square inch absolute)	14.7 psia	14.7 psia	14.7 psia	14.7 psia	14.7 psia	14.7 psia
Initial discharge rate (kilograms/second)	1.28 kg/s	1.095 kg/s	1.013 kg/s	0.939 kg/s	0.867 kg/s	0.811 kg/s
Vapor mass fraction - at exit plane	0.00092	0.0177	0.0303	0.0488	0.064	0.077
Vapor mass fraction - atmospheric jet prior to air entrainment	0.126	0.125	0.124	0.123	0.123	0.123
Exit-plane pressure (pounds per square inch absolute)	27.12 psia	24.93 psia	23.37 psia	21.26 psia	19.63 psia	18.29 psia
Exit-plane temperature (degrees Celsius)	37.86ºC	35.24ºC	33.25ºC	30.37ºC	27.99ºC	25.9ºC
Two-phase density - at exit plane (kilograms per cubic meter)	772 kg/m^3	194.6 kg/m^3	118.2 kg/m^3	70.9 kg/m^3	51.2 kg/m^3	40.1 kg/m^3
Two-phase jet density - atmospheric jet prior to air entrainment (kilograms per cubic meter)	24.13 kg/m^3	24.33 kg/m^3	24.46 kg/m^3	24.54 kg/m^3	24.6 kg/m^3	24.63 kg/m^3
Two-phase jet velocity - release from opening (meters per second)	2.97 m/s	10.1 m/s	15.4 m/s	23.75 m/s	30.35 m/s	36.25 m/s
Two-phase jet velocity after depressurization to atmosphere (meters per second)	40.27 m/s	46.03 m/s	48.29 m/s	50.6 m/s	52.22 m/s	53.25 m/s
Two-phase jet temperature (degrees Celsius)	19.6ºC	19.6ºC	19.6ºC	19.6ºC	19.6ºC	19.6ºC
Two-phase jet area – atmospheric (square millimeters)	1317 mm^2	978 mm^2	858 mm^2	756 mm^2	858 mm^2	618 mm^2
Approximate opening elevation (feet above ground)	5 feet	5 feet	5 feet	5 feet	5 feet	5 feet

As the row marked "Time from onset of initial release" shows, HF would continue escaping from a derailed cargo tanker for far longer than the initial 60-minute interval Petitioners modeled in ALOHA. It would take more than 11 hours for the railcar to empty half of its contents.

To specify release points for their dispersion modeling, Petitioners assumed the Philadelphia derailment would occur at 39.951407 latitude, -75.182143 longitude (where the recommended rail route passes under Walnut Street, along the Schuylkill River), and that the Memphis derailment would occur at 35.108501 latitude, -89.989521 longitude (where the recommended rail route crosses Lamar Avenue).

B. Cargo truck release inputs

1. Cargo tanker design and contents

All of Petitioners' cargo truck release cases assume the following:

- Liquid anhydrous HF (AHF) is transported in a 5,300-gallon cargo tank trailer, designed to be hauled by a semi-truck (aka 18-wheeler).
- The tank is about 5 feet. in diameter and 36 feet long.
- The tank is designed to be unloaded through a 2-inch diameter liquid standpipe ending in a 90-degree elbow and controlled by a ball valve.

These estimates are based on Petitioners' analysis of information on the HF cargo truck tank trailers used by Honeywell, Inc (the sole identified current U.S. manufacturer of anhydrous HF for refinery use).

2. Unloading conditions

For their refinery unloading case, Petitioners assumed that the cargo tank would contain 18,160 kilograms of anhydrous HF at 38^0C (100^0F) (essentially liquid full). The Petitioners assumed the release would occur at the top of the tank, approximately 10 feet off the ground (accounting for the trailer's undercarriage), where the 2" liquid unloading line emerges from protective housing and connects to flexible hose. Petitioners assumed that the cargo tank would be pressurized with nitrogen for unloading—resulting in an assumed pressure of 100 pounds per square inch gauge (psig) at the top of tank.

Petitioners used these assumptions to derive the following release parameters.

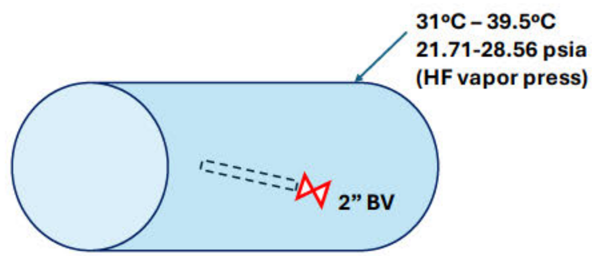
Figure 14: Cargo tanker unloading release parameters – Torrance, California

AHF cargo tank liquid content temperature	**38ºC**
Time from onset of initial release	0 h (early on)
Pressure at railcar head space (pounds per square inch absolute)	114.7 psia
Pressure atmospheric (pounds per square inch absolute)	14.7 psia
Initial discharge rate (kilograms per second)	45.0 kg/s
Vapor mass fraction - at exit plane	0.0
Vapor mass fraction - atmospheric jet prior to air entrainment	0.128
Exit-plane pressure (pounds per square inch absolute)	27.24 psia
Exit-plane temperature (degrees Celsius)	38ºC
Two-phase density - at exit plane (kilograms per cubic meter)	908 kg/m^3
Two-phase jet density - atmospheric jet prior to air entrainment (kilograms per cubic meter)	23.78 kg/m^3
Two-phase jet velocity - release from opening (meters per second)	22.89 m/s
Two-phase jet velocity after depressurization to atmosphere (meters per second)	27.05 m/s
Two-phase jet temperature (degrees Celsius)	19.6ºC
Two-phase jet area – atmospheric (square millimeters)	69950 mm^2
Approximate opening elevation (feet above ground)	10 feet

Petitioners assumed the tanker truck would be parked next to the Torrance refinery's alkylation unit, at 33.853256 latitude, -118.330786 longitude, at the time of the release.

3. Cargo tanker crash conditions

For both of their truck crash cases, Petitioner assumed the crash would cause the cargo tanker to roll onto its side (tilt 90 degrees) and the standpipe ball valve to open, resulting in a release height approximately 2.5 feet off the ground. Consistent with their railcar release scenarios, because the vehicle would still be enroute to a refinery, they did not assume any added nitrogen pressurization.



For each case, Petitioners assumed that at the time of the release, liquid HF inside the truck would be at the temperature corresponding to the summer daytime high for the crash location city: 39.5°C (103°F) for Phoenix, and 31°C (88°F) for Baton Rouge—resulting in an assumed vapor pressure at the top of the tank (in the head space) of 28.56 psia (pounds per square inch absolute) for the Phoenix case, and 21.71 psia for the Baton Rouge case.

Petitioners used these assumptions to derive the following release parameters.

Figure 15: Cargo truck crash scenarios--release parameters for Baton Rouge, Louisiana and Phoenix, Arizona

AHF liquid temperature inside cargo tank (degrees Celsius and Fahrenheit)	**Phoenix, 39.5ºC (103ºF)**	**Baton Rouge, 31ºC (88ºF)**
Diameter of cargo tank opening (centimeters) [assumes release from the overhead ball valve from the truck]	5.25 cm	5.25 cm
Area of the opening (square millimeters)	2165 mm^2	2165 mm^2
Diameter (inches) **and location of ball valve opening** [top of truck]	2" BV + 90 elbow + 8 ft incl standpipe in horizontal orientation	2" BV + 90 elbow + 8 ft incl standpipe in horizontal orientation
HF Concentration (percent)	100%	100%
Pressure at tank head space (pounds per square inch absolute)	28.56 psia	21.71 psia
Pressure atmospheric (pounds per square inch absolute)	14.7 psia	14.7 psia
Initial discharge rate (kilograms per second)	4.79 kg/s (liquid inlet)	4.58 kg/s (liquid inlet)
Discharge period (s) in two-phase (hours)	0.62 h (liquid inlet)	0.7 h (liquid inlet)
Vapor mass fraction - at exit plane	0.00367	0.0
Vapor mass fraction - atmospheric jet prior to air entrainment	0.136	0.078
Exit-plane pressure (pounds per square inch absolute)	28.06 psia	21.71 psia
Exit-plane temperature (degrees Celsius)	38.94ºC	31ºC
Two-phase density - at exit plane (kilograms per cubic meter)	536 kg/m^3	926 kg/m^3
Two-phase jet density - atmospheric jet prior to air entrainment (kilograms per cubic meter)	22.34 kg/m^3	38.47 kg/m^3
Two-phase jet velocity - release from opening (meters per second)	4.13 m/s	2.28 m/s
Two-phase jet velocity after depressurization to atmosphere (meters per second)	45.76 m/s	25.13 m/s
Two-phase jet temperature (degrees Celsius)	19.6ºC	19.6ºC
Two-phase jet area – atmospheric (square millimeters)	4686 mm^2	4735 mm^2
Jet area to exit-plane area - area expansion factor	2.2	2.2
Approximate opening elevation (feet above ground)	2.5 feet (assumes car tilted 90-deg) on its side	2.5 feet (assumes car tilted 90-deg) on its side

C. General ALOHA modeling assumptions

Petitioners used the latest available version of the ALOHA model, 5.4.7, to estimate threat zones associated with the hazardous chemical release of HF. The model predicts concentration as a function of time and location. Petitioners directed ALOHA to generate a map of the plume (or cloud) and to specify contours corresponding to the Acute Exposure Guideline Levels for either 10-minute exposures, or 60-minute exposures for HF, depending on which exposure interval best matched the peaks predicted by the model.

The computational outputs in the results section (Part IV) capture the main assumptions Petitioners directed ALOHA to use to generate plume maps for each transportation scenario included in the petition.

III. ALOHA results

The following computational outputs describe the ALOHA modeling results and general assumptions for each transportation scenario. For each scenario, the first output is a "Threat Zone" plot or an area within which a hazard level is predicted to exceed a level of concern. The second output is a "Threat at Point" plot which is a line graph showing specific information about hazards at a point of interest over time. The third output is a "Source Strength" plot which shows the rate at which HF enters the atmosphere.

Together, these ALOHA output plots provide data visualizations of the ALOHA hazard prediction, which is a function of properties of the hazard source; the scenario environment; and ALOHA's air dispersion model (the computer model that predicts the movement and dispersion of a gas in the atmosphere). Some of the mapped plumes appear truncated because EPA's recommended version of ALOHA makes predictions for only the first hour (60 minutes) after a release begins, and/or only for distances within 10 kilometers (or 6.2 miles) of the source.[7] For these cases, the plume graphics presented below, and the derivative concentric-circle graphics and population counts included in petition body, understate the true ultimate extent of the HF cloud at levels at and above AEGL-1, and below AEGL-2.

Petitioners used the ALOHA results for the Torrance truck unloading scenario (at Figure 19, below) to do a supplemental analysis of cloud speed. They selected points within the AEGL-3 plume mapped by ALOHA; estimated the time at which HF concentrations at each point would first reach the relevant AEGL-3 level (170 parts per million); and compared those times to the assumed start of release time to estimate how quickly the edge of the AEGL-3 cloud would spread. The following table summarizes their results. The estimated speed varied slightly from point to point, but consistently close to the assumed wind speed of 3 meters per second.

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[7] *See* ALOHA v5.4.7, Online Help, Limitations section ("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") (available within ALOHA software platform; screenshot on file with NRDC Petitioners).

Distance from release point for each representative point (kilometers)	**Time to reach 170 ppm** (minutes from release start)	**Speed** (meters / second)	**Speed** (miles / hour)[8]
1	6.5	2.6	5.8
1.5	9.5	2.7	6.0
2	12.5	2.7	6.0
2.5	14.5	2.8	6.3
3	18.5	2.7	6.0

[8] *See* CalculatorSoup, https://www.calculatorsoup.com/calculators/conversions/speed.php (visited Jan. 31, 2025). One meter per second is equivalent to about 2.237 miles per hour. *Id*.

Figure 16: ALOHA results for Trainer, Pennsylvania railcar unloading scenario

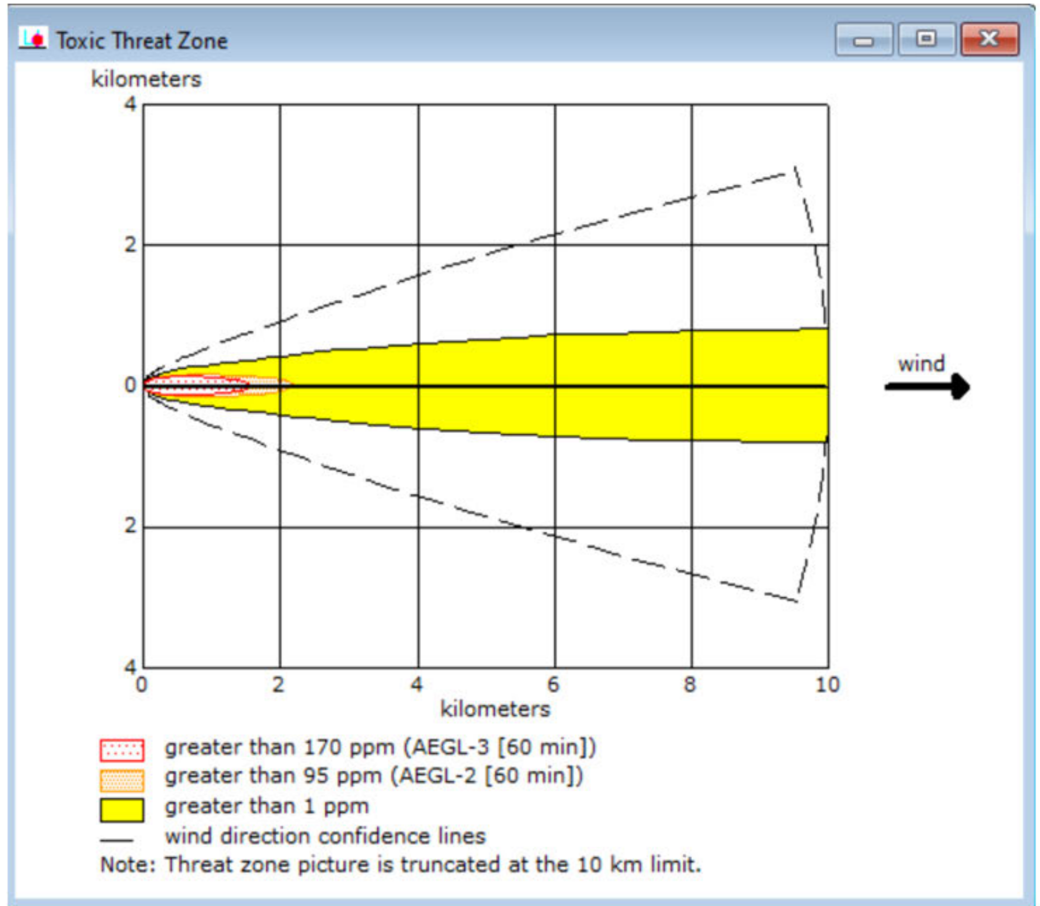
SITE DATA:
Location: TRAINER PA (MONROE), PENNSYLVANIA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours EDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF_23.79KG_M3 Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 25° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 8.62 kilograms/sec Source Height: 15 feet
Release Duration: 10 minutes
Release Rate: 517 kilograms/min
Total Amount Released: 5,172 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 1.6 kilometers --- (170 ppm = AEGL-3 [60 min])
Orange: 2.2 kilometers --- (95 ppm = AEGL-2 [60 min])
Yellow: greater than 10 kilometers --- (1 ppm)



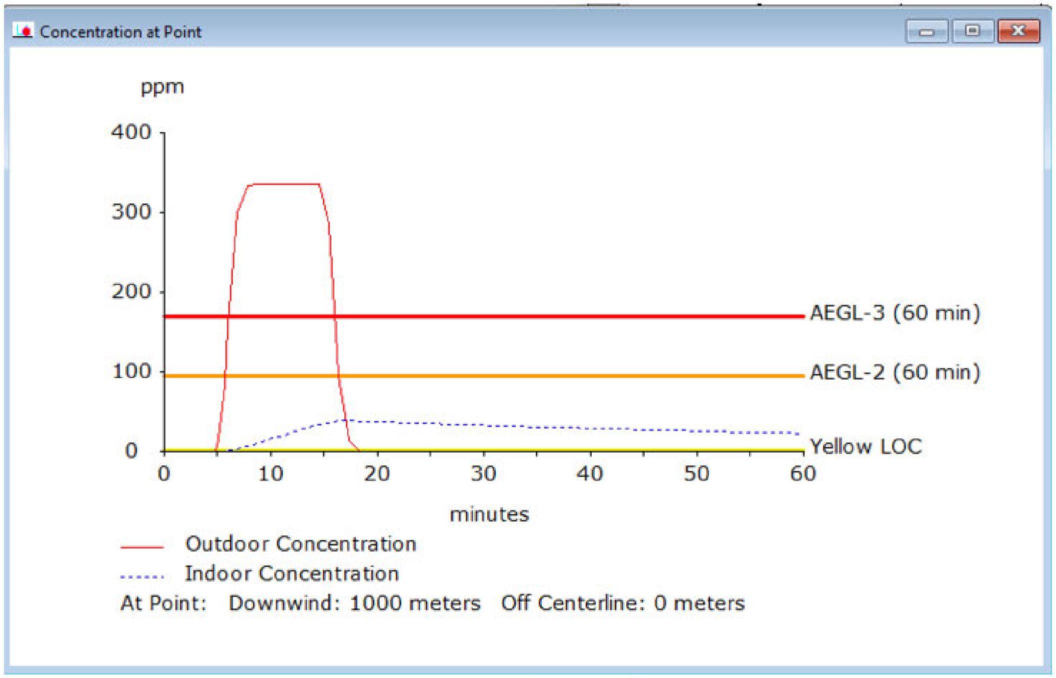
SITE DATA:
Location: TRAINER PA (MONROE), PENNSYLVANIA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours EDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF_23.79KG_M3 Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 25° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 8.62 kilograms/sec Source Height: 15 feet
Release Duration: 10 minutes
Release Rate: 517 kilograms/min
Total Amount Released: 5,172 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 1.6 kilometers --- (170 ppm = AEGL-3 [60 min])
Orange: 2.2 kilometers --- (95 ppm = AEGL-2 [60 min])
Yellow: greater than 10 kilometers --- (1 ppm)



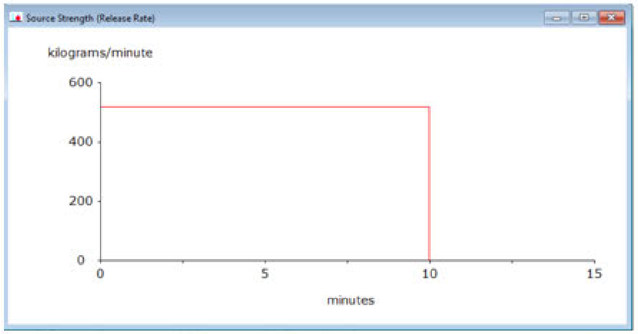


Figure 17: ALOHA results for Philadelphia, Pennsylvania and Memphis, Tennessee derailment scenario[9]

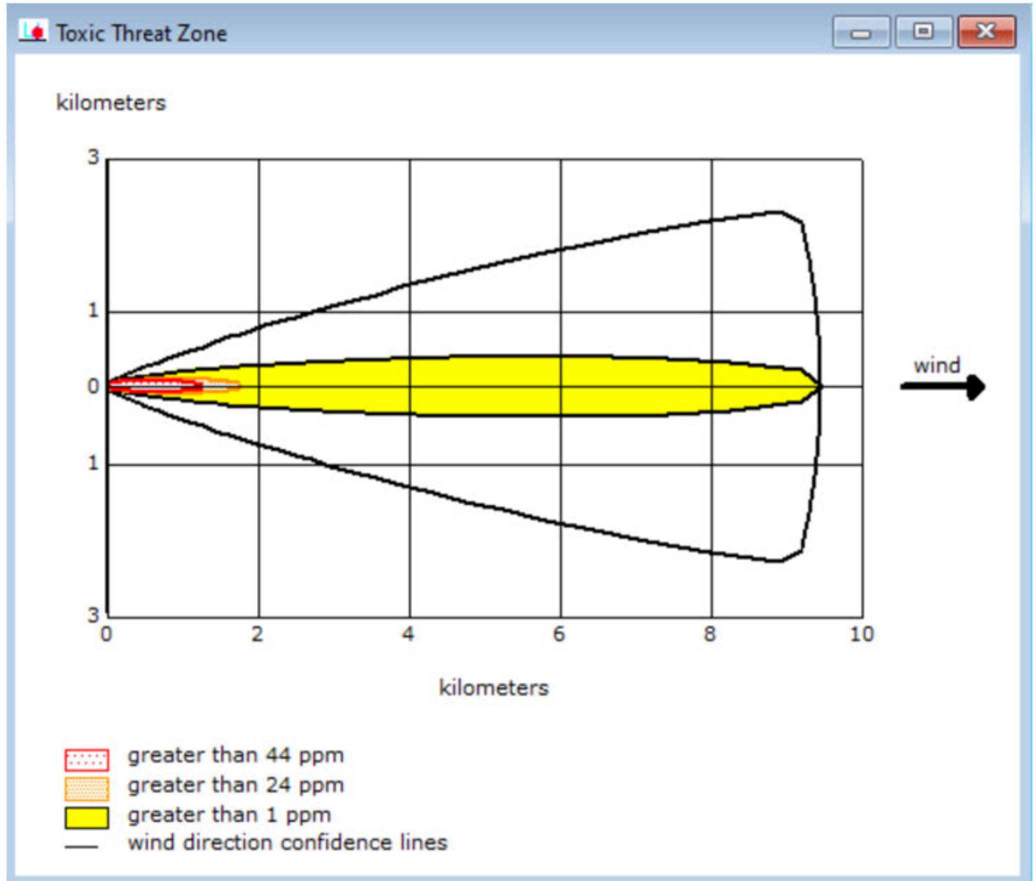
SITE DATA:
Location: TRAINER PA APPROACH, PENNSYLVANIA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours EDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF_24.13KG_M3 Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 25° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 1.28 kilograms/sec Source Height: 5 feet
Release Duration: 60 minutes
Release Rate: 76.8 kilograms/min
Total Amount Released: 4,608 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 1.3 kilometers --- (44 ppm)
Orange: 1.8 kilometers --- (24 ppm)
Yellow: 9.5 kilometers --- (1 ppm)



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9 For the Memphis scenario, Petitioners changed the location but preserved the other outputs and assumptions used to develop the Philadelphia derailment ("Trainer approach") scenario.

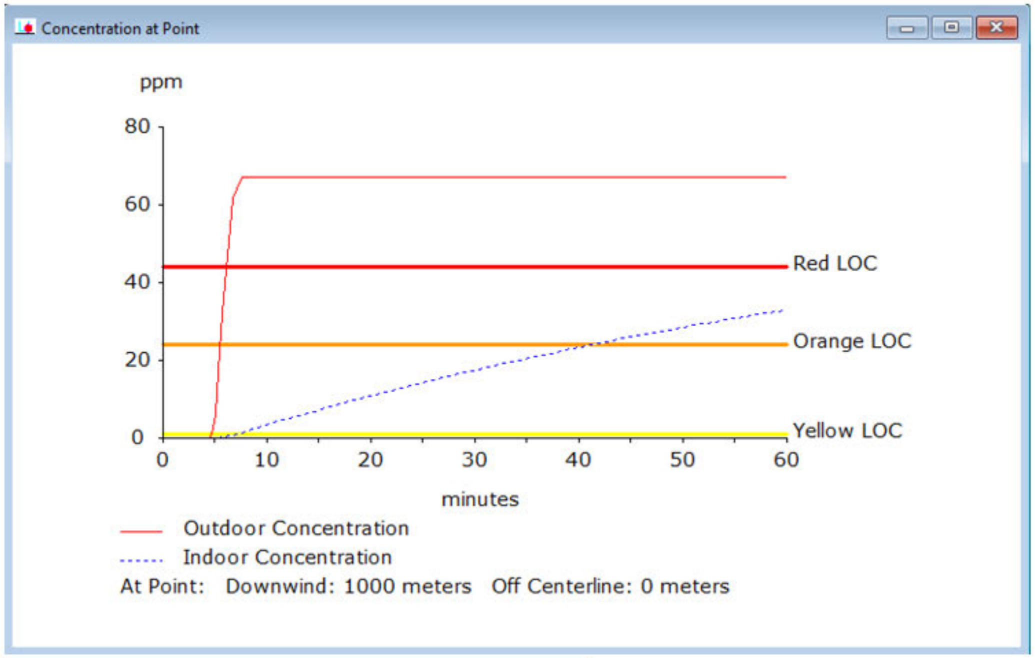
SITE DATA:
Location: TRAINER PA APPROACH, PENNSYLVANIA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours EDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF_24.13KG_M3 Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 25° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 1.28 kilograms/sec Source Height: 5 feet
Release Duration: 60 minutes
Release Rate: 76.8 kilograms/min
Total Amount Released: 4,608 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 1.3 kilometers --- (44 ppm)
Orange: 1.8 kilometers --- (24 ppm)
Yellow: 9.5 kilometers --- (1 ppm)



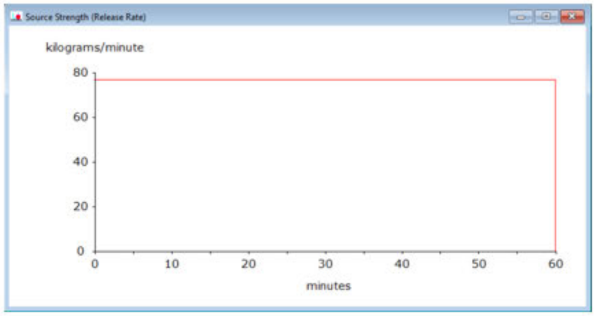


Figure 18: ALOHA results for Torrance, California cargo truck unloading scenario

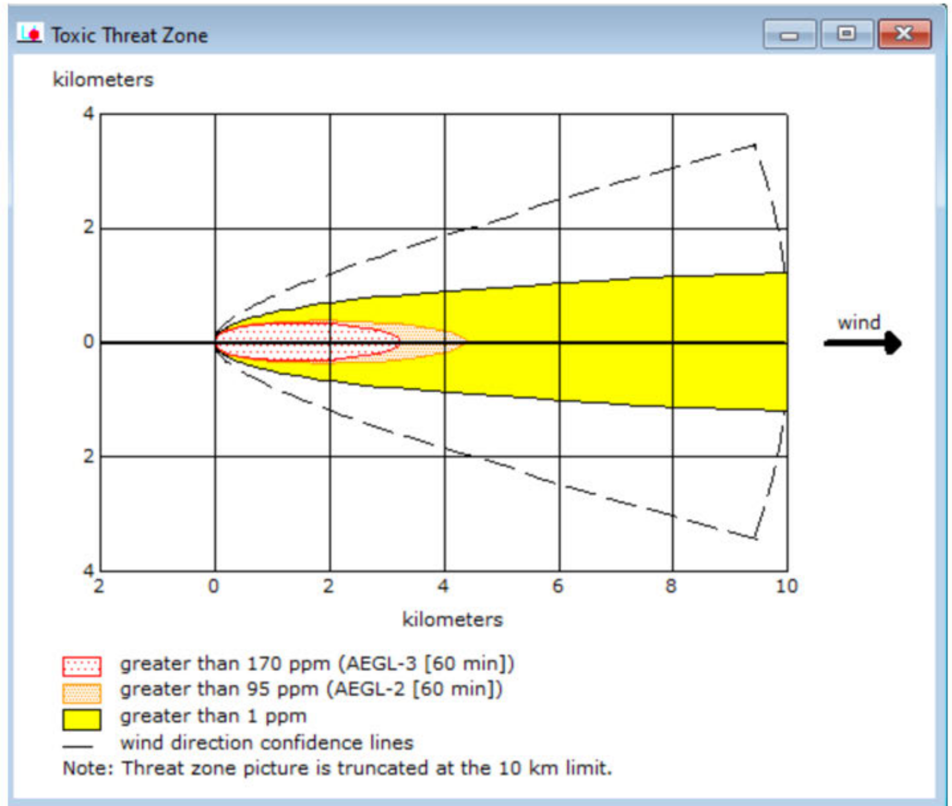
SITE DATA:
Location: TORRANCE ALKYLATION, CALIFORNIA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours PDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF_23.78KG_M3 Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 25° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 45 kilograms/sec Source Height: 10 feet
Release Duration: 6.67 minutes
Release Rate: 2,700 kilograms/min
Total Amount Released: 18,009 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 3.2 kilometers --- (170 ppm = AEGL-3 [60 min])
Orange: 4.4 kilometers --- (95 ppm = AEGL-2 [60 min])
Yellow: greater than 10 kilometers --- (1 ppm)



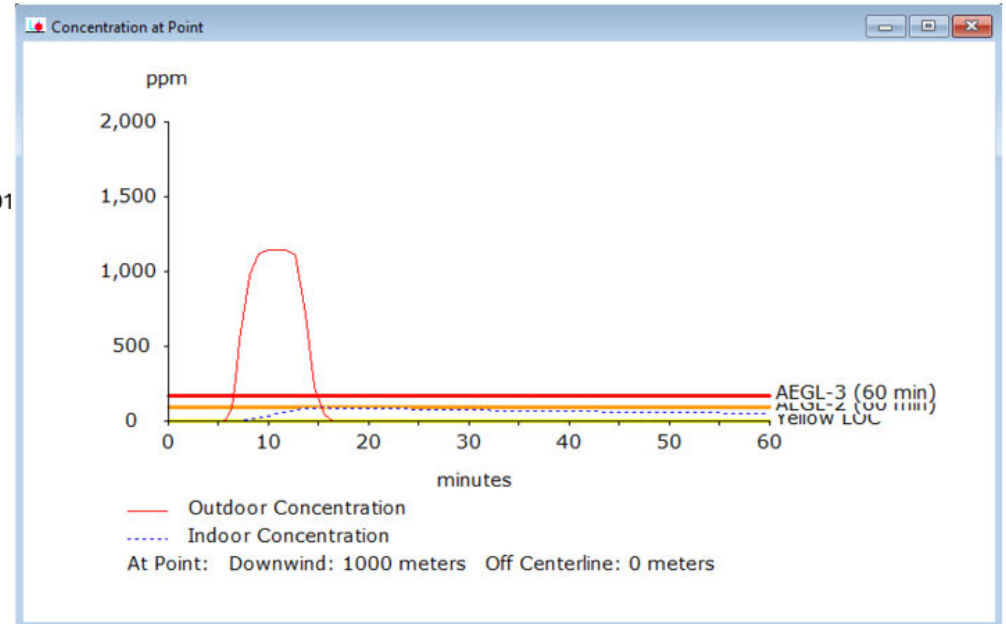
SITE DATA:
Location: TORRANCE ALKYLATION, CALIFORNIA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours PDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF_23.78KG_M3 Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 25° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 45 kilograms/sec Source Height: 10 feet
Release Duration: 6.67 minutes
Release Rate: 2,700 kilograms/min
Total Amount Released: 18,009 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 3.2 kilometers --- (170 ppm = AEGL-3 [60 min])
Orange: 4.4 kilometers --- (95 ppm = AEGL-2 [60 min])
Yellow: greater than 10 kilometers --- (1 ppm)



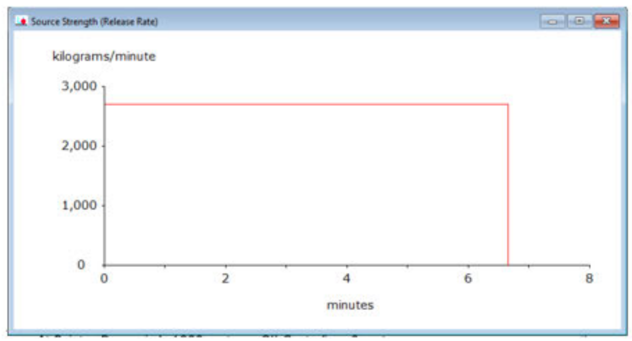


Figure 19: ALOHA results for Baton Rouge, Louisiana cargo truck crash scenario

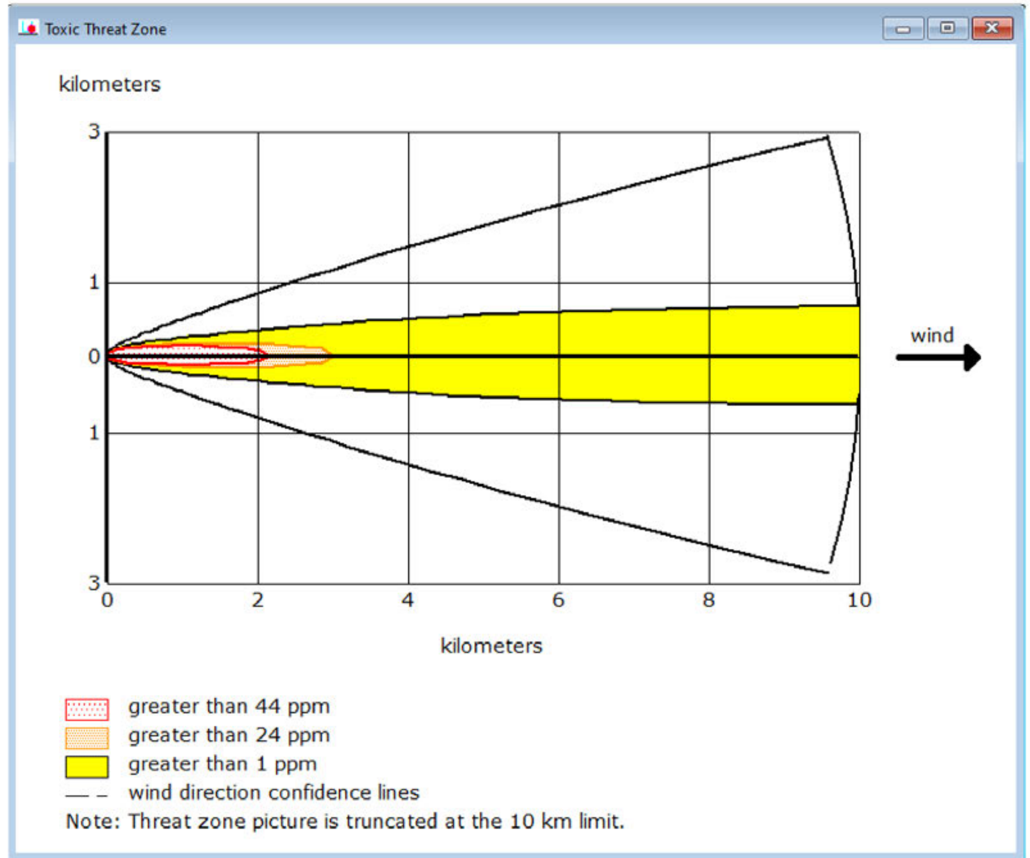
SITE DATA:
Location: BATON ROUGE (TRUCK OVERTURN), LOUISIANA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours CDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF (SCENARIO 3, TRUCK OVERTURN, BATON ROUGE
Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest   Cloud Cover: 5 tenths
Air Temperature: 31° C   Stability Class: D
No Inversion Height   Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 3.55 kilograms/sec   Source Height: 2.5 feet
Release Duration: 41.7 minutes
Release Rate: 213 kilograms/min
Total Amount Released: 8,882 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 2.2 kilometers --- (44 ppm)
Orange: 3.0 kilometers --- (24 ppm)
Yellow: greater than 10 kilometers --- (1 ppm)



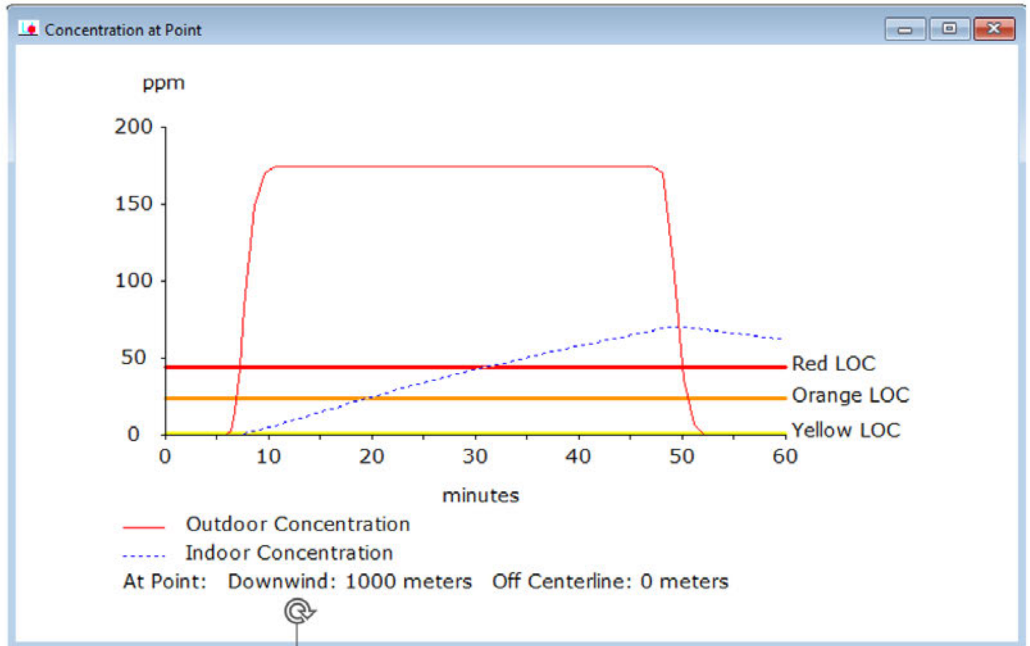
SITE DATA:
Location: BATON ROUGE (TRUCK OVERTURN), LOUISIANA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours CDT (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF (SCENARIO 3, TRUCK OVERTURN, BATON ROUGE
Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 19.5° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 31° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 3.55 kilograms/sec Source Height: 2.5 feet
Release Duration: 41.7 minutes
Release Rate: 213 kilograms/min
Total Amount Released: 8,882 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 2.2 kilometers --- (44 ppm)
Orange: 3.0 kilometers --- (24 ppm)
Yellow: greater than 10 kilometers --- (1 ppm)



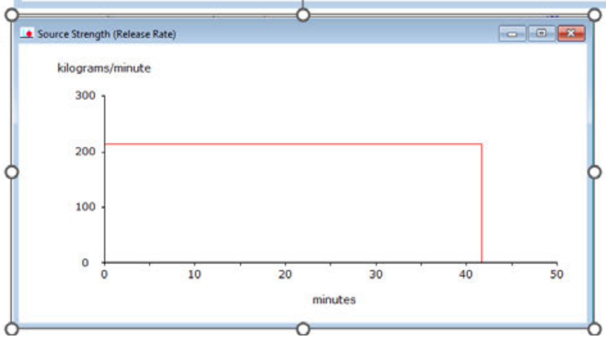


Figure 20: ALOHA results for Phoenix, Arizona cargo truck crash scenario

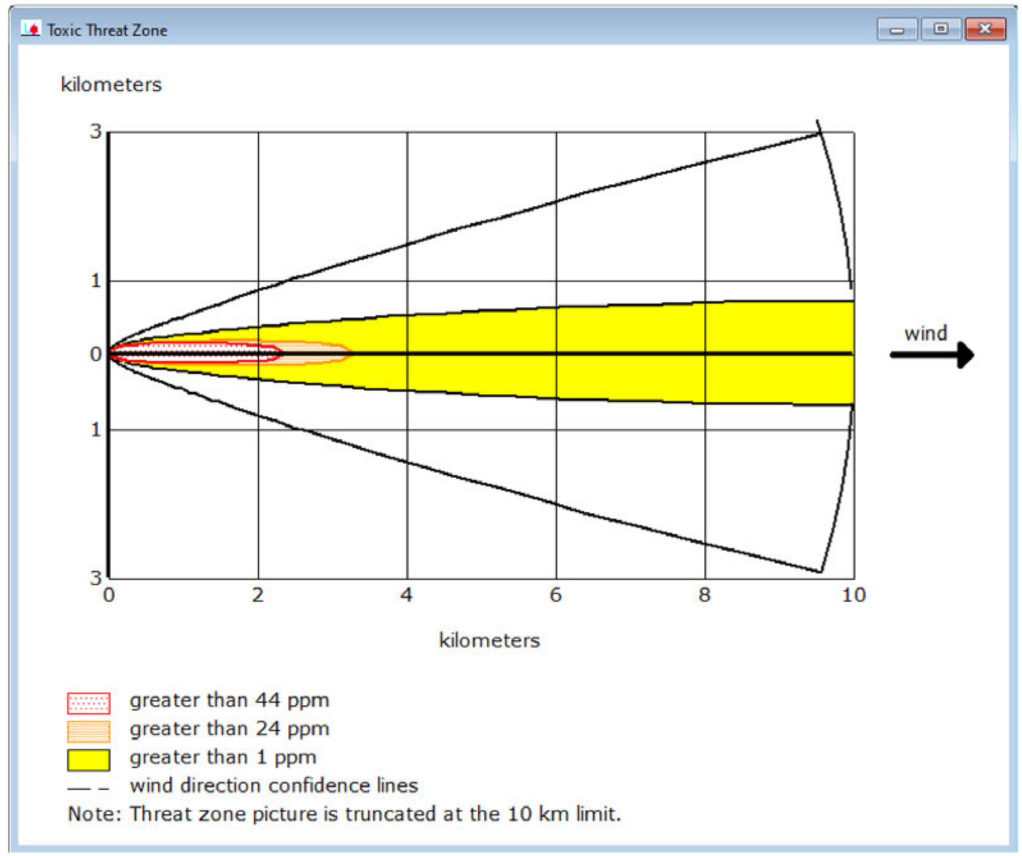
SITE DATA:
Location: PHOENIX (TRUCK OVERTURN), ARIZONA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours MST (user specified)

CHEMICAL DATA:
Chemical Name: PSEUDO HF (SCENARIO 3, TRUCK OVERTURN, PHOENIX)
Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 18.4° 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: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 39.5° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 4.05 kilograms/sec Source Height: 2.5 feet
Release Duration: 37.4 minutes
Release Rate: 243 kilograms/min
Total Amount Released: 9,088 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 2.4 kilometers --- (44 ppm)
Orange: 3.3 kilometers --- (24 ppm)
Yellow: greater than 10 kilometers --- (1 ppm)



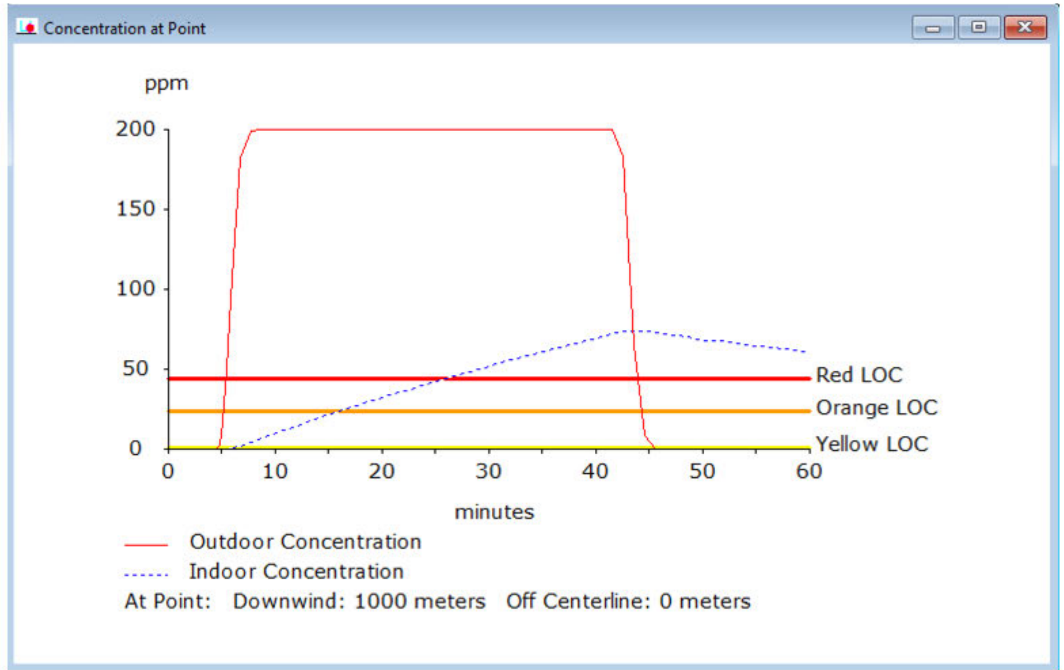
SITE DATA:
Location: PHOENIX (TRUCK OVERTURN), ARIZONA
Building Air Exchanges Per Hour: 0.75 (user specified)
Time: June 18, 2024 1400 hours MST (user specified)

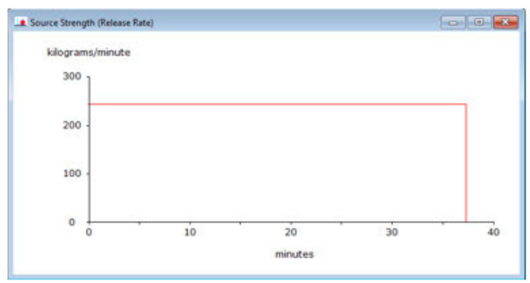
CHEMICAL DATA:
Chemical Name: PSEUDO HF (SCENARIO 3, TRUCK OVERTURN, PHOENIX)
Molecular Weight: 20.01 g/mol
Ambient Boiling Point: 18.4° C
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 3 meters/second from 270° true at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 39.5° C Stability Class: D
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:
Direct Source: 4.05 kilograms/sec Source Height: 2.5 feet
Release Duration: 37.4 minutes
Release Rate: 243 kilograms/min
Total Amount Released: 9,088 kilograms
Note: This chemical may flash boil and/or result in two phase flow.

THREAT ZONE: (HEAVY GAS SELECTED)
Model Run: Heavy Gas
Red : 2.4 kilometers --- (44 ppm)
Orange: 3.3 kilometers --- (24 ppm)
Yellow: greater than 10 kilometers --- (1 ppm)





IV. Petition threat zone graphics and population tables

To develop the concentric-circle graphics and population tables presented in the petition, Petitioners took the plume centerline distance ALOHA plotted for each scenario (shown in Part III, above) and rotated that distance 360 degrees around each assumed release point. The resulting concentric circles describe the full geographic area (or zone) that could end up captured within each plume, depending on wind direction at the time of the release.

Petitioners then used ArcGIS Pro software (version 3.2.2) and the datasets cited below to estimate the total residential population, and population within each of the subgroups described on their tables, within the (1) central circles shaded in red on their graphics (denoting the area where HF levels in the modeled plume would reach or exceed AEGL-3); (2) the rings shaded orange in their graphics (denoting the areas where HF levels would reach or exceed AEGL-2, but remain below AEGL-3); and (3) the rings shaded yellow in their graphics (denoting the areas where HF levels would reach or exceed AEGL-1, but remain below AEGL-2).

Petitioner used Esri's Living Atlas of the World[10] to obtain the relevant population data in GIS format.

To estimate total residential population, the number of people less than 5 years old, and the number of people more than 65 years old, Petitioners used Census data from the American Community Survey (ACS).[11] Petitioners used the same source to estimate the number of people in poverty (those whose income over the past year fell below the Federal poverty line)[12], and the number of people 5 years and older living in limited-English households (those in which "no one 14 and over speak[s] English only, or speaks a language other than English at home and speaks English very well).[13] The same source shows that the 12.7% of U.S. residents are living in poverty, and that 4.5% live in linguistically isolated households.

To estimate the number of people with asthma, coronary heart disease, and chronic obstructive pulmonary disorder (COPD), Petitioners used the CDC's Population Level Analysis and Community Estimates (PLACES) data on the prevalence of each

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[10] *See* Esri, *ArcGIS Living Atlas of the World*, https://livingatlas.arcgis.com/en/home/ (last visited Jan. 31, 2025).
[11] *See* ArcGIS, *ACS Population Variables – Boundaries*, https://www.arcgis.com/home/item.html?id=f430d25bf03744edbb1579e18c4bf6b8 (last visited Jan. 31, 2025).
[12] *See* ArcGIS, *ACS Poverty Variables – Boundaries*, https://www.arcgis.com/home/item.html?id=0e468b75bca545ee8dc4b039cbb5aff6 (last visited Jan. 31, 2025).
[13] *See* ArcGIS, *English Ability and Linguistic Isolation Variables – Boundaries*, https://www.arcgis.com/home/item.html?id=0c4d1027de6b4d6eb896d95f1240e1aa (last visited Jan. 31, 2025).

condition.[14] The same source shows that approximately 10.5% of U.S. residents have asthma; 6.8% have coronary heart disease; and 12.7% have COPD.

Petitioners used the geospatial analysis tool Summarize Within[15] to compute the counts within each shaded disk and ring. Where these areas overlap with census tract boundaries, the tool assumes the population at risk in the shaded area, relative to the census tract, is proportional to the amount of overlap. For example, a census tract with a population of 4,000 people that 50% overlaps a ring corresponding to a scenario's AEGL-2 level would be assessed as having 2,000 people at risk.

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[14] *See* Diana Lavery, *CDC PLACES Now Contains Measures on Health-Related Social Needs*, Esri ArcGIS Blog (Oct. 2, 2024), https://www.esri.com/arcgis-blog/products/arcgis-living-atlas/health/cdc-places-2024/.
[15] *See* Esri, *Summarize Within (Analysis) ArcGIS Pro 3.4*, https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/summarize-within.htm (last visited Jan. 31, 2025).