Air Monitoring and Emergency Response

Embassy Science Fellowship, 2022

Crude Oil Response

Response Objective:
Responder Safety and Community Safety.

Preparedness for Fire and No-Fire Spill Response Scenarios

Crude Oil Response

Agenda:

- Air Sampling plan and response considerations
- Contaminants of Concern
- Instrumentation
- Plume modeling

Air Monitoring Plan

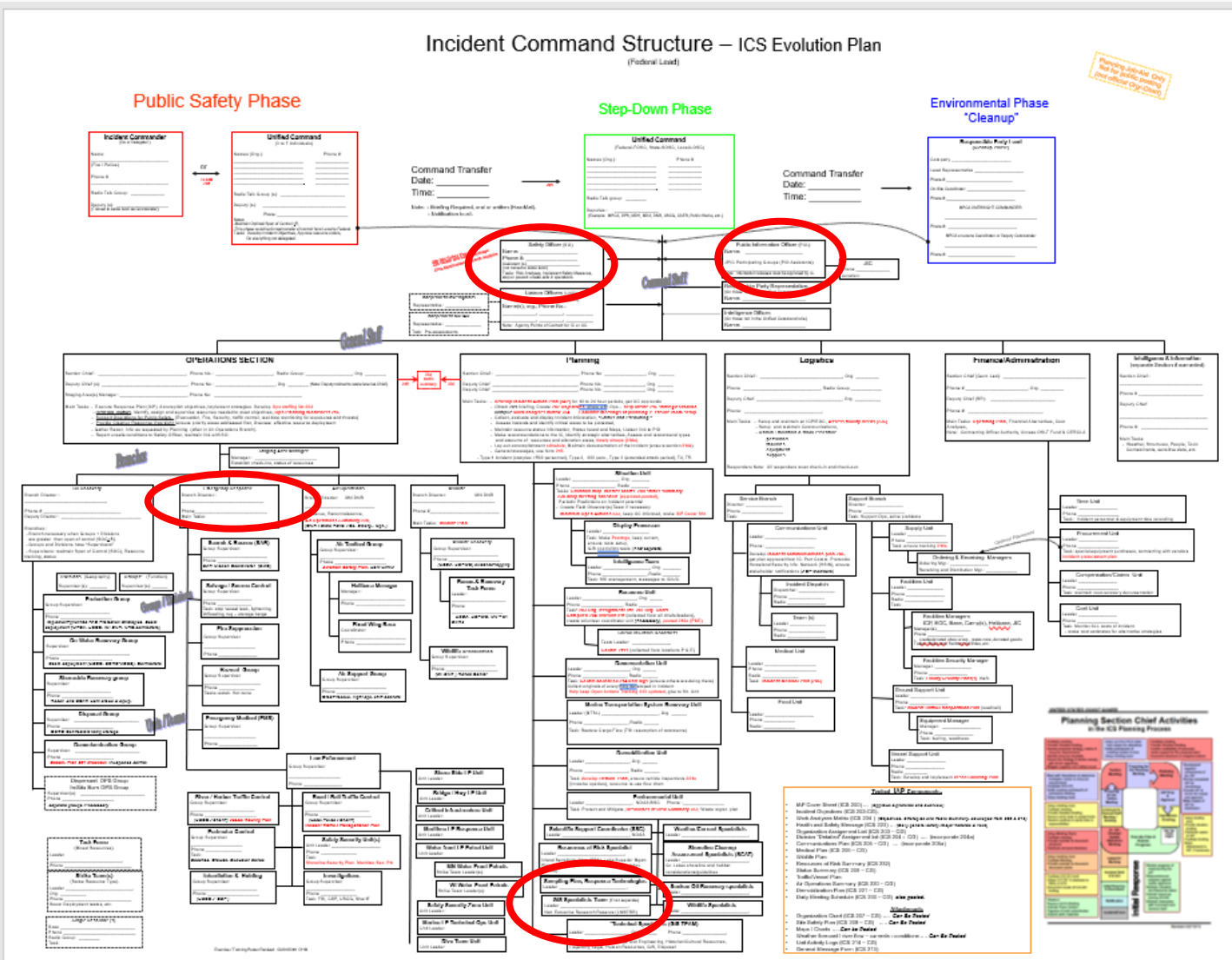
Every Incident needs an air monitoring plan approved by Unified Command.

Crude Oil Spill, Michigan, USA, 2010
Photo by: Andre J. Jackson, Detroit Free Press

Air Monitoring Plan

Air Monitoring Efforts will immediately overlap:

- Safety
- Operations
- PIO
- ENV Unit



Air Monitoring Plan (AMP)

A basic Plan should have many of these components:

- Purpose for Monitoring,
  - Responder Safety,
  - Community Safety,
- Purpose for Sampling,
  - Quantifying exposures and health risks
- Data Quality Objectives.
- Monitoring Parameters, contaminants of concern
  - Established action levels
- Scope of Work, Monitoring/Sampling Teams

Air Monitoring Plan cont.

- A description and map of the areas to be monitored
  - Fixed monitoring sites
  - Activity-based monitoring
  - Continuous and changing monitoring zones
- Field Methods, Sample collection,
- Quality Assurance/Quality Control Processes
- Data Analyses
- Communication of Results

Common Objectives for an Emergency AMP

- Identify and quantify hazardous substances or conditions on- and off-site
- Establish hot, warm, cold zones
- Track temporal / spatial changes in airborne contaminants over incident
- Determine protective actions for worker / community safety
- Determine proper selection of work practices / engineering controls
- Determine level of PPE required
- Identify additional medical monitoring needs

Monitoring vs. Sampling

- “Air Monitoring” refers to the use of direct-reading instruments producing real-time data.

- “Air Sampling” refers to the use of a specific media that collects a sample that is sent to the laboratory for analysis.

Worker Health & Safety – Air Monitoring

- Air Monitoring and Respiratory Protection
  - Flammable vs. toxic
  - Benzene is often used as a key decision point.

Air Monitoring/Sampling Location Considerations

- Meteorological conditions
  - For modeling
  - Determine air monitoring locations
  - Impacts on chemical properties
- Collection areas
  - Dependent on type of recovery
  - Secondary release points
- Staging areas
- Indoor environments
  - Evacuation vs. Shelter In Place
  - Re-occupancy

Air Monitoring Limitations

Direct-reading instruments

- “Real Time” data needs to be collated, reviewed and shared.
- Telemetry range, if you have telemetry
- Sensors often not compound specific
- Limited detection levels
- May not detect certain classes of compounds

Air Sampling

- Sample collection and analysis Limitations
  - Sampling collected is limited by sampling supplies
  - Requires additional and specialized equipment
  - Requires more time for results

- Sample analysis Benefits
  - Compound or class specific
  - Identifies unknowns
  - Greater accuracy

Personal air sampling station

Start Responses with an All-Hazards Approach

- Oxygen-deficient atmospheres
- Combustible/explosive atmospheres
- Radiation
- Toxic atmospheres –
  - Immediately Dangerous to Life or Health (IDLH)
  - Short Term Exposure Limits (STEL) and Ceilings
  - Time Weighted Averages (TWAs)

Protect the Public
Quantify community exposure risks

Community Air Monitoring

- Air plumes, particularly when fire is involved, rise high and settle somewhere else.
- Air monitoring near the perimeter of the fire may show little.
- Air monitoring in a village 10 KM away where the plume came down may show a lot.
- **Community monitoring has to go off-site!**

Typical Parameters to look for:

- Spill
  - O_2
  - Explosive Levels – LEL/UEL
  - H_2S
  - Benzene
  - Hexane
  - Total organic vapors (VOCs)

- Fire
  - O_2
  - CO
  - Explosive Levels – LEL/UEL
  - H_2S
  - Benzene
  - Hexane
  - Total organic vapors (VOCs)
  - SO_2 / NO_2
  - Particulates* (PAHs, metals, etc.)
  - Formaldehyde
  - Black Carbon (BC)

Product Specific Considerations

- Physical/chemical properties of the substance(s)
  - Flash point
  - Freezing/boiling point
  - Vapor pressure
  - Vapor density
  - Ionization potential
  - LEL/UEL
  - Sweet/heavy Crude

Case Example:

Sweet Crude

- *Flash Point = 95 degrees (F)*
- *LEL = 0.8%*
- *UEL = 8.0%*
- *API Gravity = 45*
- *Specific Gravity = 0.82*
- *Benzene Concentration 1700 – 1900 ppm*

Product Specific Considerations

- Condensates
  - Methane, ethane, propane, butane
  - CO_2
  - Benzene

- Ethanol
  - Caustics (NaOH)
  - Ammonia
  - Acids (H_2SO_4)
  - Ethanol
- Biodiesel
  - Methanol (high IP)
  - Caustics (NaOH, KOH)
  - Hexane

Crude Oil Constituents and Risks

Example Safety Data Sheet (SDS) for crude oil

CAS #	Component	Percent
Not Available	C10 to C49+ isoparaffins	32.5
Not Available	C10 to C49+ cyclic paraffins	19.8
Not Available	C12+ mono-aromatics	8.5
Not Available	Poly aromatic hydrocarbons	4.9
Not Available	C10 to C49+ n paraffins	3.7
Not Available	C16+ di-aromatics	2.8
Not Available	C7 cyclic paraffins	2.6
Not Available	C8 cyclic paraffins	2.3
Not Available	Trimethyl benzenes	2.3
Not Available	Dimethyl naphthalene	1.5
142-82-5	n-Heptane	1
96-37-7	Methylcyclopentane	0.9
111-84-2	Nonane	0.9
Not Available	Dimethyl benzenes	0.9
75-28-5	Isobutane	0.9
111-65-9	Octane	0.9
Not Available	Trimethyl naphthalene	0.9
110-54-3	Hexane	0.9
96-14-0	3-Methylpentane	0.8
592-27-8	2-Methylheptane	0.8
591-76-4	2-Methylhexane	0.8
109-66-0	Pentane	0.8
108-88-3	Toluene	0.8
124-18-5	Decane	0.7
Not Available	Tetramethyl benzenes	0.7
Not Available	Pentamethyl benzenes	0.6
78-78-4	Isopentane	0.6

CHEMICAL	ADVERSE EFFECTS
Benzene	Inhalation can result in irritation of eyes, skin, and respiratory system. Ingestion of highly contaminated food or water can cause vomiting, dizziness, confusion, convulsions, and death. Long term exposure can cause anemia, and leukemia
Hydrogen sulfide	Inhalation can result in irritation to eyes, skin, and respiratory system, exposure to 500 ppm can result ir loss of consciousness; chronic effects can result in headaches, impaired memory or motor function
Ethylbenzene	Inhalation can result in irritation to eyes, skin, and respiratory system, exposure to higher levels can cause dizziness or vertigo
Toluene	Inhalation can result in irritation to eyes, skin, and respiratory system; can also cause tiredness, confusion, impaired memory, nausea, loss of appetite, and loss of hearing. Exposure to high levels can result in unconsciousness and death; ong term exposure can affect nervous system or kidneys
Xylenes	Inhalation can result in irritation to eyes, skin, and respiratory system; can also cause headaches, lack of coordination, dizziness, confusion and impaired balance. Exposure to high levels can result in unconsciousness and death; long term exposure can have central nervous system effects, and changes in liver and kidney
Generic alkanes (including octane, hexane, and nonane)	Inhalation of high levels of n-hexane can cause numbness in the feet and hands and weakness in feet and lower legs. Inhalation of high levels of some alkanes can result in asphyxiation long term exposure to n-hexane can also cause weakness and loss of feeling in the arms and legs
Naphthalene	Exposure to high levels can cause nausea, diarrhea, blood in urine; exposure to extremely high levels can be fata ; long term exposure associated with red blood cell effects, resulting in fatigue, lack of appetite , etc.
Polycyclic Aromatic Hydrocarbons (PAHs)	Inhalation can cause irritation to eyes and skin cancer, possible reproductive effects, immune system effects; Several of the PAHs are known animal carcinogens and probable human carcinogens

Oil Spill Parameters

Pollutant	Instrument Type/ Analytical Method	Purpose
VOCs, BTEX compounds	Air samples collected in canisters; laboratory analysis using method TO-15 (GC/MS analysis)	Health risk consideration and characterization of air quality
VOCs	Air samples collected in canisters; laboratory analysis using SNMOC/TO-14 (GC/FID analysis)	Event analysis
H_2S	On-site sampling and laboratory analysis (Teledyne API 101E)	Hourly high sensitivity H_2S measurements for evaluation of portable H_2S measurements
H_2S, total VOC	Portable emergency response units (AreaRAE, MultiRAE, MiniRAE)	Odor response
PAHs	Air samples collected with PUF/XAD-2 units; laboratory analyses using TO-13A (GC/MS analysis)	Health risk consideration and characterization of air quality
PM_{10}, $PM_{2.5}$	Airborne particle collection and on-site measurement (E-BAM)	Health risk consideration and characterization of air quality
PM_{10}	Portable detector unit (DataRam)	Early response
24 hr Integrated $PM_{2.5}$	Airborne fine particle collection using BGI PQ 200; laboratory gravimetric analysis	Health risk consideration and characterization of air quality
$PM_{2.5}$, Ozone	Airborne particle collection and ozone measurements using FEM instruments	Health risk consideration, characterization of air quality and calculate AQI
BTEX compounds and dispersant chemicals	TAGA - mobile lab; Triple quadrapole mass spectroscopy	Real time mobile monitoring for Health risk and characterization of air quality, and oil dispersant monitoring

EPA Example Monitoring during the BP gulf oil spill.

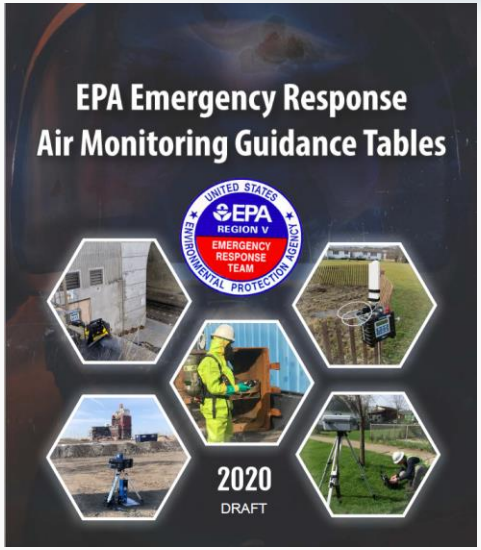
Refined Oil Spills

- Keep in mind constituent percentages and risks in a refined product incident.

Question ?

Do products from artisinal refining present higher risks ?

EPA Air Monitoring Tables



Response Tables (as listed below)

Table Number	Response Type	
1	Acid	Spill or Release
2	Ammonia	Spill or Release
3	Chemical Plant	Fire
4	Chlorine	Spill or Release
5	Electroplating Facility	Spill, Release, or Fire
6	General Industrial	Fire
7	Landfill	Release or Fire
8	Magnesium	Fire
9	Mercury	Spill or Release
10	Oil	Spill, Release, or Fire
11	Pesticide or Fertilizer	Fire
12	Phosphorus	Spill, Release, or Fire
13	Tire Fire	Fire
14	Wood-Treating Facility	Spill or Release
15	Volcano	Natural Disaster
16	Ethanol Release	Spill, Release, or Fire
17	Spacecraft Debris	Spill, Release, or Fire
18	Special Event	Riot
19	Clandestine Lab	Fire
20	Plastics Fire	Fire
21	Water Quality Monitoring	Release
22	Battery Site	Release or Fire

EPA Air Monitoring Tables

Table 10 - Oil (Spill, Release, or Fire)

	Instrument Guidance						Regulatory Guidance							Reference		
							Occupational Action Levels		AEGL-1			PAC-1	ERPG-1	Air Sampling		
Target Compound[1]	Instrument	Detection Level	Intrinsically Safe (Y/N)	IP	LAMP, CF (ISO)	Conversion	TWA	IDLH	1-hr	4-hr	8-hr	15-min TWA	1-hr	Media	Method	Flow Rate/ Total Volume
VOCs and Gases																
Benzene	UltraRAE PGM-7360 (benzene specific mode)**	0.05-200 ppm	Y	9.24 eV	9.8 lamp, 0.55	1 ppm = 3.19 mg/m^3	PEL = 1 ppm, ST 5 pm REL = 0.1 ppm, ST 1 ppm TLV = 0.5 ppm, ST 2.5 ppm	500 ppm	52 ppm	18 ppm	9 ppm	52 ppm	50 ppm	Sorbent Tube, Anasorb CSC, 226-01/Summa Canister/Tedlar bag	NIOSH 1501 TO-15 TO-3	≤0.2 L/min; 5-30 L ≤200 mL/min
	Dräger Tube	0.25-2 ppm, 2-10 ppm	Y		NA											
	Dräger Chip	0.2-10 ppm	Y													
	MultiRAE/AreaRAE PID**	0-2000 ppm	Y		10.6 lamp, 0.47											
	TVA 2020***	0.5-2,000 ppm (PID) 1-10,000 ppm (FID)	Y		10.6 lamp 0.294 (10 ppm) - 0.282 (1000 ppm)											
Carbon Monoxide	MultiRAE/AreaRAE CO Sensor	0-500 ppm, 0-2000 ppm ext range	Y	14.01 eV	NA	1 ppm = 1.15 mg/m3	PEL = 50 ppm REL = 35 ppm, C 200 ppm TLV = 25 ppm	1200 ppm	83 ppm*	33 ppm*	27 ppm*	75 ppm	200 ppm	Five-layer aluminized gas sampling bag, 262-01	OSHA ID 210	1 L/min, 2-5 L
	Dräger Tube	5- 150 ppm, 100-700 ppm	Y													
	Dräger Chip	5-150 ppm	Y													
Hydrogen Sulfide	MultiRAE/AreaRAE H_2S Sensor	0-100 ppm, 0-1000 ppm ext. range	Y	10.46 eV	NA	1 ppm = 1.4 mg/m^3	PEL = C 20 ppm, 50 ppm (10 mins) REL = C 10 ppm (10 mins) TLV = 1 ppm, ST 5 ppm	100 ppm	0.51 ppm	0.36 ppm	0.33 ppm	0.51 ppm	0.1 ppm	Sorbent Tube, Silica Gel, For Hydrogen Sulfide, Sulfur Dioxide, 266-177	OSHA 1008 NIOSH 6013	0.05 L/min; 12 L 0.1 to 1.5 L/min (0.2 L/min rec); 1.2-40 L
	Dräger Tube	≥0.2-6 ppm	Y													
	Dräger Chip	≥0.2-5 ppm	Y													
	SPM Flex	0.001-9.999 ppm	Y													
	MultiRAE/AreaRAE PID**	0-2000 ppm	Y		10.6 lamp, 3.3											
Sulfur Dioxide	MultiRAE/AreaRAE SO_2 Sensor	0-20 ppm	Y	12.3 eV	NA	1 ppm = 2.62 mg/m^3	PEL = 5 ppm REL = 2 ppm, ST 5 ppm TLV = ST 0.25 ppm	100 ppm	0.2 ppm	0.2 ppm	0.2 ppm	0.2 ppm	0.3 ppm	Preloaded Cassette, MCE, Coated, Sodium Carbonate, 225-9005	NIOSH 6004	0.5-1.5 L/min; 4-200 L
	Dräger Tube	≥0.1-3 ppm	Y													
	Dräger Chip	≥0.4-10 ppm	Y													
	SPM Flex	0.01-2.5 ppm	Y													

EPA Air Monitoring Tables *cont.*

Instrument Guidance							Regulatory Guidance							Reference		
							Occupational Action Levels		AEGL-1			PAC-1	ERPG-1	Air Sampling		
Target Compound[1]	Instrument	Detection Level	Intrinsically Safe (Y/N)	IP	LAMP, CF (ISO)	Conversion	TWA	IDLH	1-hr	4-hr	8-hr	15-min TWA	1-hr	Media	Method	Flow Rate/ Total Volume
PAHs - as particulates																
PAHs****	TSI DustTrak II***	0.001-400 mg/m^3	N	NA	NA	NA	PEL = 0.2 mg/m^3 REL = 0.1 mg/m^3 TLV = 0.2 mg/m^3	80 mg/m^3	NA	NA	NA	0.15 mg/m^3	NA	Preloaded Cassette, PTFE, 2.0um, 37mm, 2 Piece, 225-1713 & Sorbent Tube, XAD-2, 226-30-04	NIOSH 5506 TO-13A	2 L/min; 200-1000 L
	TSI DustTrak DRX***	0.001-150 mg/m^3	N													
	Pocket Pump TOUCH	NA	Y													
	Aircon-2	NA	N													
Radiation[2]																
Radiation	Model 192 Micro R Exposure Rate Meter	0-5,000 µR/hr	N	NA	NA	NA	10 µR/hr	NA	NA	NA	NA	NA	NA	RADeCO Filter Paper (2")	RSSOP 209/501	α = 2500 ft^3 β/γ = 1250 ft^3
	Ludlum Model 2241-2 w/ 44-9 Pancake Probe	0-9,999 R/hr or 999,000 cpm	N				300 cpm									
	Ludlum Model 2241-3 w/ 44-9 Pancake Probe	0-9,999 R/hr or 999,000 cpm	N				300 cpm									
	Ludlum Model 2241 w/ 43-90 Alpha Scintillator	0-9,999 R/hr or 999,000 cpm	N				300 cpm									
	Model 2241 w/ Model 44-10 NaI Detector	0-9,999 R/hr or 999,000 cpm	N				300 cpm									

Dispersants and Burning

Dispersant chemicals should be included in the air monitoring plan.

Examples:

- *2-butoxyethanol*
- *dipropylene glycol monobutyl ether*

In-Situ Burn Plumes should be included in the Air Monitoring Plan.

Examples:

- *Particulate Matter, PAHs*
- *SO2, NO2, CO*
- *combustion byproducts*

Air Monitoring

Instrument Characteristics

- Selectivity
- Resolution/Sensitivity/Range
- Calibration
- Environmental conditions
- Correction factors
- Response times
- Sensor cross-sensitivities
- Sensor poisons/overexposure
- Intrinsic safety

DISCLAIMER

- Instruments mentioned in this presentation are not an endorsement but are examples of equipment utilized in responses.

Instrumentation - Monitoring

- RAE Systems:
  - AreaRAE/Pro – fixed networks
  - MultiRAE/Pro – handheld, multi-gas
  - UltraRAE 3000 – Benzene, VOCs
- ProRAE Guardian Suite
  - Laptop Software for running multiple instruments simultaneously.

MultiRAE Pro has 20 interchangeable sensors

Instrumentation - Monitoring

- TSI DustTrak Particulate Air Monitoring
  - DustTrak II
  - DRX Handheld
  - DataRam Portable & DR4
- ThermoScientific Toxic Vapor Analyzer (TVA) 2020
  - FID/PID capability

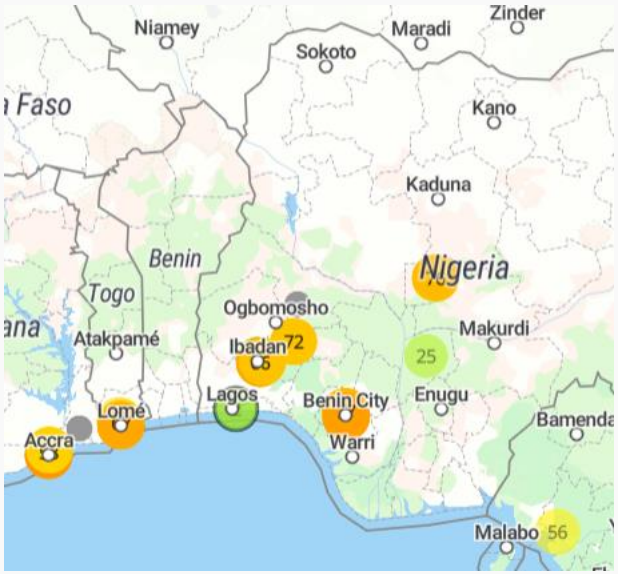
Give Timely Feedback to UC and Public !

Community Activism - monitoring

PurpleAir

There is an increasing use of Purple Air PM 2.5 sensors by local communities to document air quality and share it on the web.

- The sensors are relatively inexpensive.
- This data, however, is not generally validated.
- Data is often cited when industrial fire and wildfire smoke impacts communities.



Instrumentation-Sampling

Summa Canisters

Tedlar bags w/vacuum box

Air Sampling pumps/filters

Portable Analyses

ThermoScientific GEMINI

Identify a broad range of unknown chemicals and explosives in the field using Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopy.

Defiant Technologies – FROG-5000

Portable GC PID, Micro Gas Chromatograph with Photoionization Detector

- Draeger - colorimetric tubes/chips,
- SPM Flex - tape meters,

Sampling – Mobile Labs

EPA portable GC/MS

Action Levels

Every Air Monitoring plan should have a clear table on action levels.

- Worker/Responder
  - Turn around / exit thresholds
  - PPE requirement range & ceiling
  - No respiratory protection required levels
- Community
  - Acute and Chronic exposure levels
  - Sensitive populations thresholds
  - Evacuation and Reentry Criteria

Pick your Standard.

- Acute Exposure Guideline Levels (AEGL),
  - National Advisory Committee
  - III (*most severe*), II, I (*least risk*)
  - Includes susceptible subpopulations, such as infants, children, the elderly, persons with asthma, and those with other illnesses.
  - AEGL is a category calculated for five exposure periods (10 minutes, 30 minutes, 1-hour, 4-hours, and 8-hours)
- Emergency Response Planning Guidelines (ERPG)
  - American Industrial Hygiene Association
  - Exposure periods of up to 1-hour, (think of it as a 1-hour ceiling).
  - Sensitive Populations not covered by these guidelines
  - III (most severe), II, I (least risk)

Pick your Standard.

- Temporary Emergency Exposure Limits (TEEL)
  - Department of Energy Subcommittee on Consequence Assessment and Protective Actions
  - 1- hour exposure criteria for airborne concentrations
  - Presented as Protective Action Criteria (PAC)
  - TEELs should be used to help protect the public when AEGLs or ERPGs are not available *(there are about 3,000 chemical TEELS and about 175 chemical AEGLs)*

- Minimal Risk Levels (MRLs)
  - Prepared by Agency for Toxic Substances and Disease Registry (ATSDR) jointly with EPA
  - Developed for health effects other than cancer
  - MRLs can be made for 3 different time periods [the length of time people are exposed to the chemical: acute (about 1 to 14 days), intermediate (from 15-364 days), and chronic (exposure for more than 364 days)].

Pick your Standard - Worker.

- In the USA, there are applicable Hazardous Waste Site Worker Standards:
- Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs);
- National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs)
  - Adops Short Term Exposure Limits (STEL). 15-minute exposure maximum for healthy workers routinely exposed to that chemical.
- American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs)

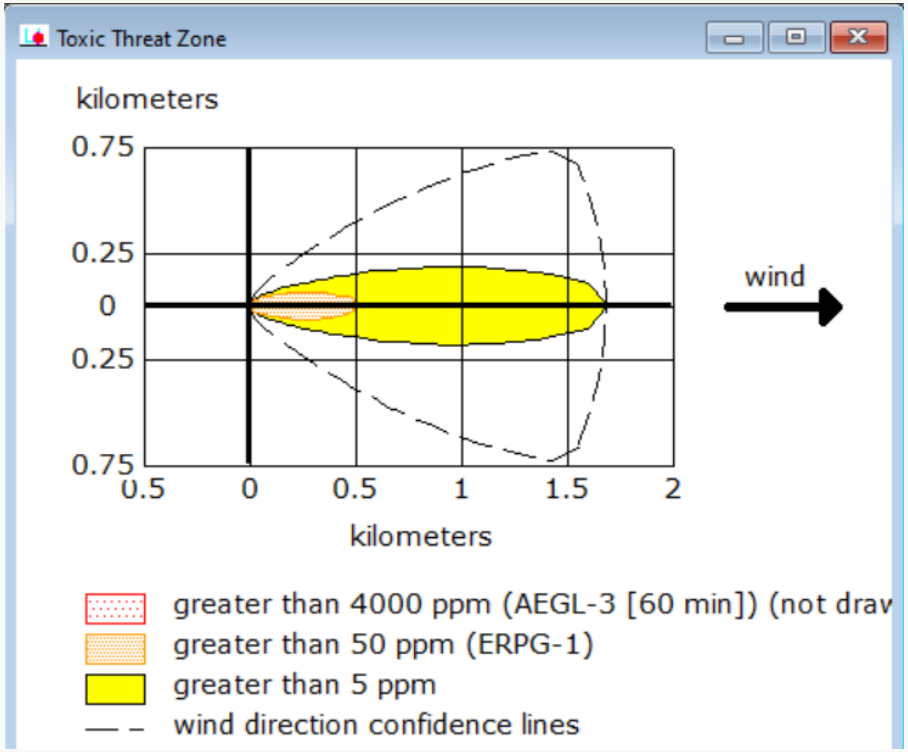
Control Zones Heirarchy

FLAMMABILITY

- LEL: Concentrations at which vapors are flammable.
- Flame Pocket Area: models use 60% LEL as are subject to pockets of flammable gas.
- Hot Zone for Flammability: 10% of LEL.

Immediately Dangerous to Life or Health (IDLH)

– can be for Flammability or Toxicity



Control Zones Heirarchy

TOXICITY

AEGL-3 Acute Exposure Guideline Levels. General population could experience life-threatening health effects or death.

ERPG 3 Healthy Persons , exposure < 1. hr. without developing life-threatening effects. (ERPGs do not include sensitive populations.)

AEGL-2 General population could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

ERPG 2 Healthy Persons, exposure <1hr. No irreversible health effects or impairment to take protective actions.

Control Zones Heirarchy

- **AEGL-1** General Population could have notable discomfort, irritation
- ERPG-1 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.
- STEL 15-minute exposure maximum for healthy workers routinely exposed to that chemical.
- PEL (OSHA) – allowable 8-hour exposure for healthy worker.
- REL (NIOSH/CDC) recommended to become a PEL
- TLV (ACGIH) 8-hour exposure maximum for healthy workers routinely exposed to that chemical.
- Odor Threshold, Chemical Specific, may be affected by prolonged exposure.

Control Zones
Ammonia – Case Example
(Aloha model)

Flammability

• LEL: 150,000 ppm	< 60 yards
• Flame Pocket Area: (96,000 ppm)	33 - 72 yards
• Hot Zone for Flammability: 10% of LEL. (15,000 ppm)	75 - 162 yards

Toxicity

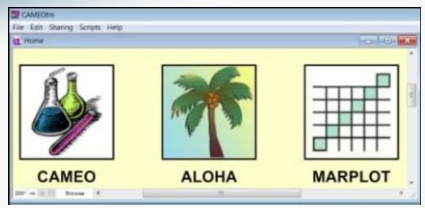
• **AEGL-3 :** 1100 ppm (60 min. category)	327 yds. (981 feet) (0.2 mi.)
• IDLH: 300 ppm	748 yds. (0.2 mi.)
• **AEGL-2** : 160 ppm (60 min. category)	1133 yds. (0.2+ mi.)
• STEL: 35 ppm (15 min.)	1.8 mi.
• **AEGL-1:** 30 ppm	2.0 mi
• Odor Threshold : <5 ppm	5.9 mi.

- DOT Emergency Response Guidebook **(ERG)**:
  - ISOLATE in all directions 1,000 ft.
  - Protective Action Distances (PAD). 1.1 mi. (Day), 2.7 mi. (night)

Comparison of Occupational Criteria for Select Compounds

Component	ACGIH	NIOSH	OSHA
Hydrogen sulfide (7783-06-4)	TWA: 1 ppm STEL: 5 ppm	CEIL: 10 ppm	CEIL: 20 ppm
Benzene (71-43-2)	TWA: 0.5 ppm STEL: 2.5 ppm	TWA: 0.1 ppm STEL: 1 ppm IDLH: 500 ppm	TWA: 1 ppm STEL: 5 ppm
Ethylbenzene (100-41-4)	TWA: 20 ppm	TWA: 100 ppm STEL: 125 ppm	TWA: 100 ppm
Toluene (108-88-3)	TWA: 20 ppm	TWA: 100 ppm STEL: 150 ppm	TWA: 200 ppm CEIL: 500 ppm

Models



EPA:

- CAMEO/ALOHA – for community-scale hazardous substance releases.

NOAA:

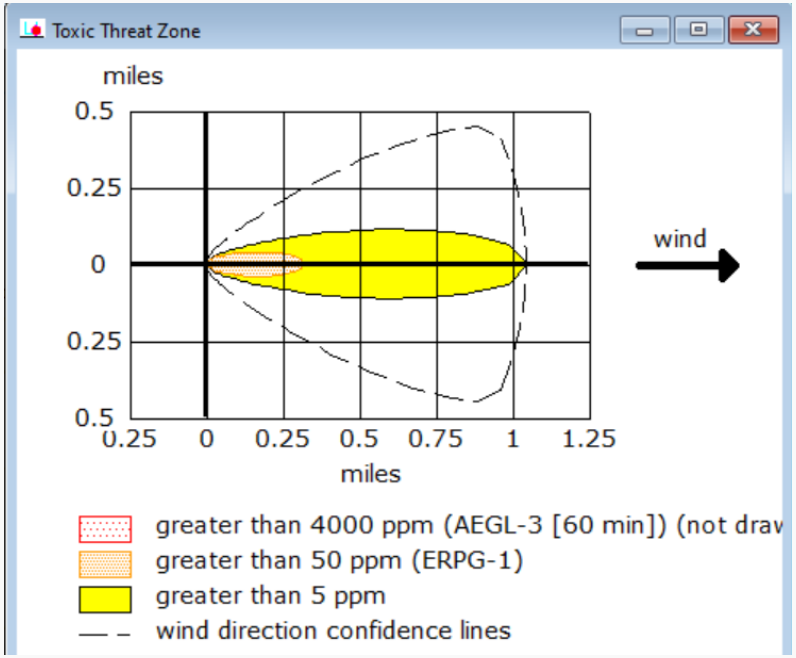
- HYSPLIT - models that simulate the dispersion and trajectory of substances transported and dispersed through our atmosphere, over local to global scales.

IMAAC:

- HPAC – Hazard Prediction and Assessment Capability. *“high-powered modeling”.*

Modeling Software

- ALOHA (Areal Locations of Hazardous Atmospheres) is a computer program designed to model chemical releases for emergency responders and planners
- Stand-Alone Plume Modeling for your laptop.

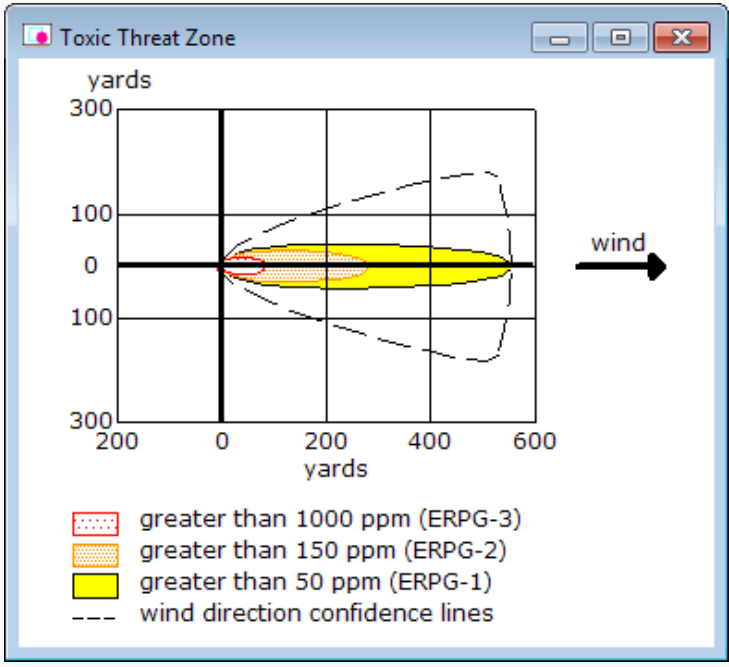


ALOHA is a product developed by the U.S. EPA and the U.S. National Oceanic and Atmospheric Administration (NOAA).

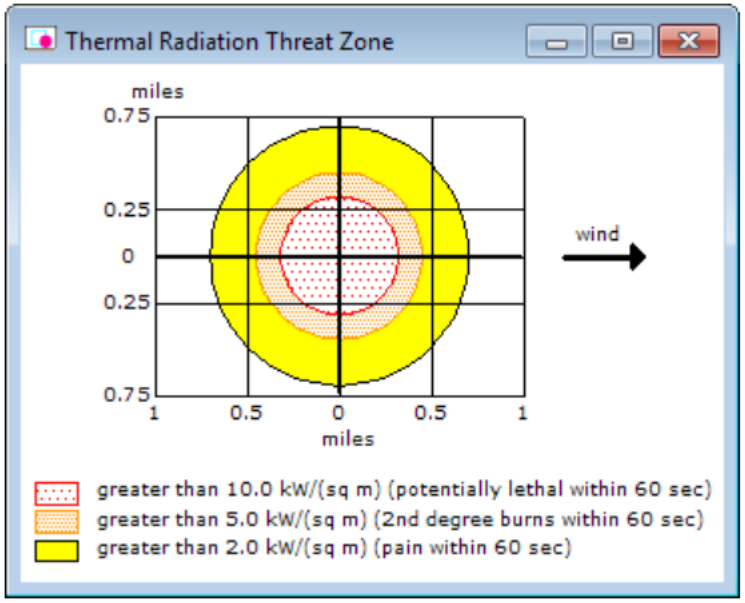
ALOHA

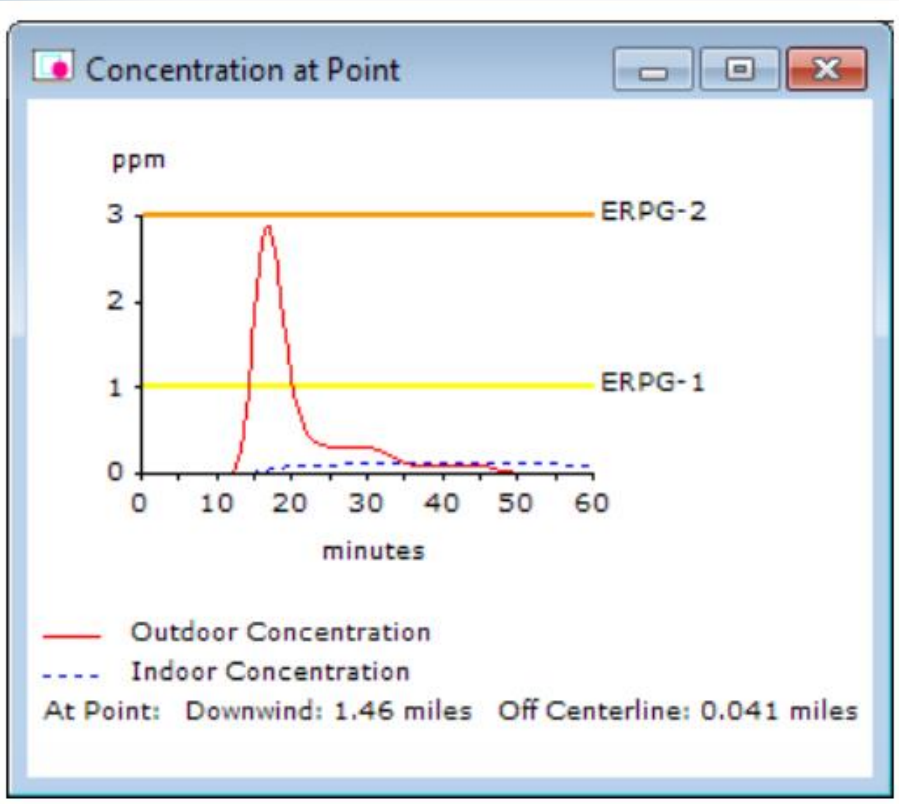
ALOHA allows you to enter details about a real or potential chemical release, and then it will generate threat zone estimates for various types of hazards.

ALOHA can model toxic gas clouds, flammable gas clouds, BLEVEs (Boiling Liquid Expanding Vapor Explosions), jet fires, pool fires, and vapor cloud explosions.



Sample ALOHA Outputs





Some sample ALOHA output. On the left, the circular thermal radiation threat zone estimates for a BLEVE. On the right, a threat point graph shows the toxic concentration hazard over time at a specific location; the horizontal lines show how the concentration compares to the chosen toxic levels of concern.

Downloading ALOHA

https://www.epa.gov/cameo/aloha-software

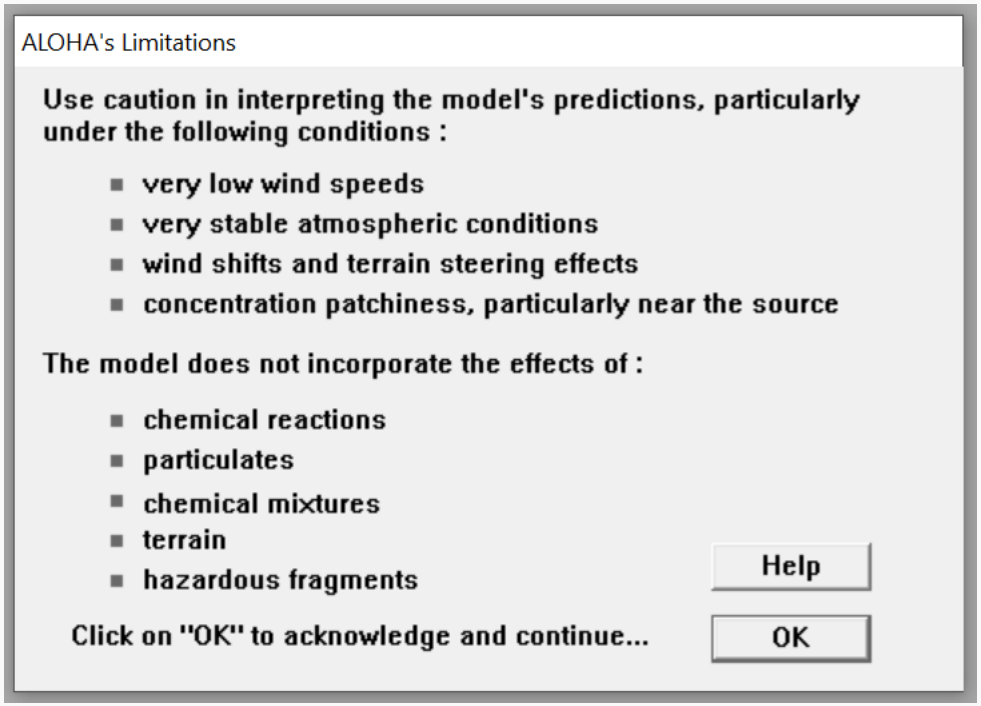
Available for download for Windows and Mac.

Start the program,

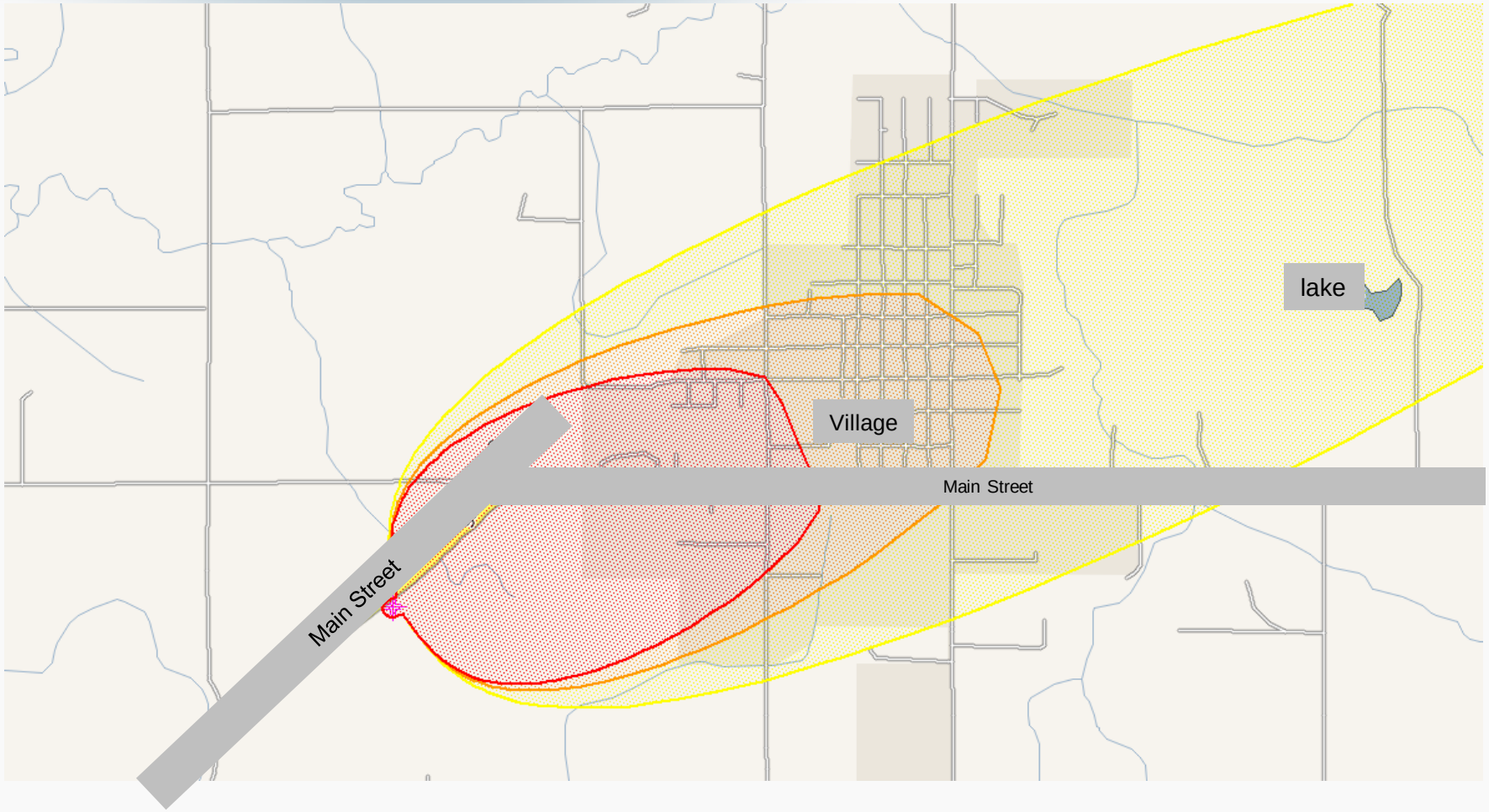
- Set up threat zone (rural, forested, urban/buildings, etc.)
- Pick chemical and release type
- Input atmospheric conditions

Display the Threat Zone.

ALOHA Limitations



Reminder – Pick Your Standards



Example: -- **IDLH**, -- **AEGL-2**, -- STEL

Wiser

WISER is a system designed to assist emergency responders in hazardous material incidents. WISER provides a wide range of information on hazardous substances, including substance identification support, physical characteristics, human health information, and containment and suppression advice.

Wiser

https://wiser.nlm.nih.gov/

Modeling: GIS support provides for isolation/protective distance overlays on a map of the incident.

Modeling Surrogates will be needed for Crude Oil.

The Safety Data Sheet (SDS) for the particular type of crude oil should identify families of chemicals of concern for air monitoring.

SECTION 1: IDENTIFICATION

1.1. Product Identifier

Product Form: Mixture

Product Name: Light Sweet Crude Oil

Synonyms: Crude Petroleum

1.2. Intended Use of the Product

A natural product derived from various oil production field primarily consisting of a complex combination of paraffinic and aromatic hydrocarbons and variable amounts of nitrogen and sulfur compounds.

Section 3 - Composition / Information on Ingredients

Soot and atmospheric deposition of PAHs

Communities affected by soot and fallout will likely ask about the risks of the residues.
- Have a capability for grab and swab testing for PAHs, particularly for carcinogenic PAHs.

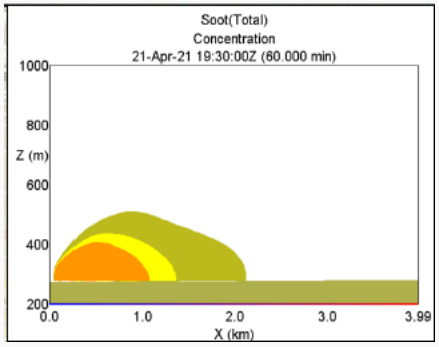
Benzo[a]anthracene
Benzo[a]pyrene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Benzo[k]fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Indeno[1,2,3-cd]pyrene
Naphthalene

Soot – Surface Dosage

Air Modeling: Cumulative dosage values based on exposure to 2.5um particulate matter.

Value	Description
Hazardous	Serious aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease and older adults; serious risk of respiratory effects in general population. Everyone should avoid all physical activity
Very Unhealthy	Significant aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease and older adults; significant increase in respiratory effects in general population. People with heart or lung disease, older adults, and children should avoid all physical activity outdoors; everyone else should avoid prolonged or heavy exertion.
Unhealthy	Increased aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease and older adults; increased respiratory effects in general population. People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion; everyone else should reduce prolonged or heavy exertion.

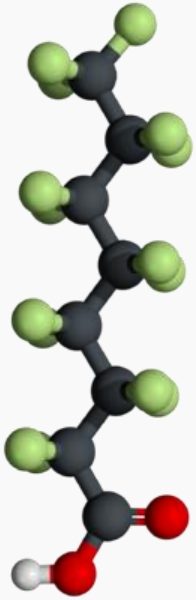
Modeled population exposure numbers are for average day and/or nighttime census figures.



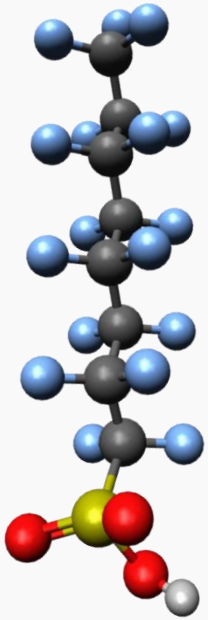
Related Things you need to know

Per- and polyfluoroalkyl substances (PFAS)

PFOA



PFOS



- A very large class of **synthetic** chemicals used for decades
  - **Chains** of carbon atoms surrounded by fluorine atoms, with different terminal ends
  - **Complicated chemistry** – thousands of different variations exist in commerce
  - **Widely used** in industrial processes and in consumer products
  - Some PFAS are known to be:
    - **Persistent** in the environment
    - **Bioaccumulative** in organisms
    - **Toxic** at relatively low (ppt) levels

PFAS has been a common component of fire fighting foams.

EPA's Approach to Tackling PFAS: Goals

RESEARCH

Invest in research, development, and innovation to increase understanding of PFAS exposures and toxicities, human health and ecological effects, and effective interventions that incorporate the best available science.

RESTRICT

Pursue a comprehensive approach to proactively prevent PFAS from entering air, land, and water at levels that can adversely impact human health and the environment.

REMEDIATE

Broaden and accelerate the cleanup of PFAS contamination to protect human health and ecological systems.

Analytical Methods: Targeted

Media	Method	Description
Non-Potable Water and Other Environmental Media aqueous and solids sampling, primarily through the Clean Water Act and methods for solid waste (SW-846) under the Resource Conservation and Recovery Act.	Method 8327/Method 3512 (preparation)	Measures a total of 24 PFAS for non-drinking water aqueous samples (groundwater, surface water, and wastewater).
	Draft Method 1633	Measures a total of 40 PFAS for 8 different environment media. Draft, single-lab validated. Method can support NPDES implementation under Clean Water Act.

Analytical Methods: Targeted & Nontargeted

Media	Method	Description
Source (air) emissions	Other Test Method (OTM) 45	EPA method that measures PFAS air emissions from stationary sources. Measures a total of 50 analytes as well as other PFAS that may be present in the sample.
	SW-846 Test method 0010: Modified Method 5 Sampling Train	For semi/non-volatiles. A performance based, modified method 5 that uses isotope dilution for targeted and non-targeted analysis.
Ambient Air	Ambient/Near-source; semivolatile and volatile	*Coming soon*
Total	Total Organic Fluorine (TOF)	*Coming soon.* Rapid screening tool to identify total PFAS presence or absence.
	Total Organic Precursors (TOP)	TOP methods are commercially available. EPA will consider the need for a thorough multi-laboratory validation study in 2021.
	High resolution mass spectrometry, non-targeted analysis (NTA)	Research method, can screen for lists of known suspects and can discover new or unknown analytes.

Questions ?

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