CAMEO

DOE Meteorological Coordinating Council

ALOHA F&E Overview
May 7, 2007
San Antonio, TX

ALOHA: Background

- Jointly developed by NOAA and EPA
- Gaussian and Heavy Gas dispersion algorithms
- Designed for short duration, short range incidents (scaling model)
- Multiple time-dependent source models (tank, puddle, gas pipeline, and direct)
- Recently upgraded to include fires and explosions
- Seamless interaction with CAMEO and MARPLOT

ALOHA can be downloaded at www.epa.gov/oem/cameo.

Who Uses ALOHA*

- First Responders (Fire and Police Service) - 35%
- State/Local Planners - 25%
- Industry - 10%
- Other - 30%
  - Academics
  - Environmental Organizations
- Approximately 60,000 downloads

*** Based on a user survey completed in 2006**

Design Challenges: Interface

- Don’t ask questions responders can’t answer. Emergency incidents may be data sparse environments.
- Responders may have limited knowledge of uncertainties.
- Minimize non-conservative results and guide users to credible science.

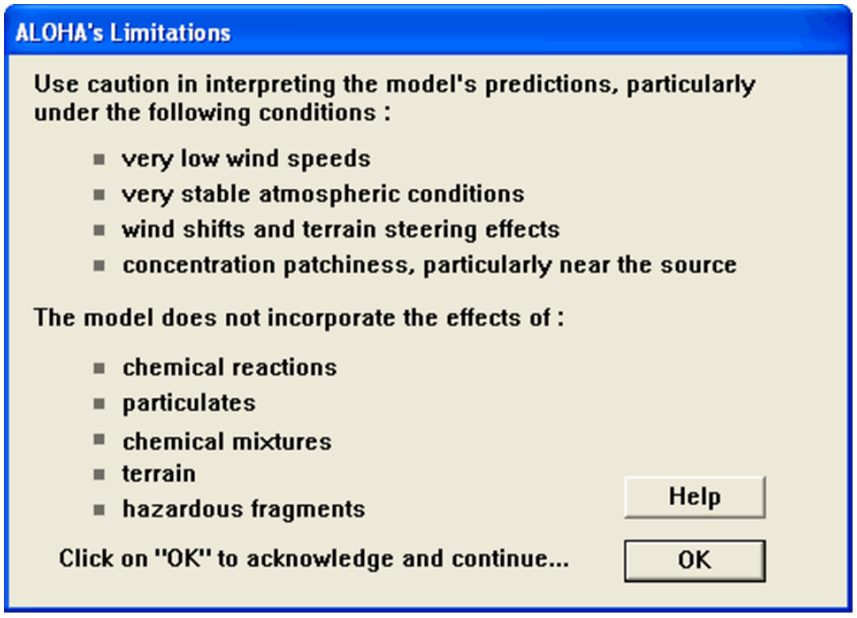
ALOHA is first and foremost a response tool and many of the design criteria were established with first responders in mind.

User-Driven Design Criteria

- ALOHA must run in the field and be quick to set up:
  - Provides cues for infrequent users
  - Asks questions that can reasonably be answered
  - Minimize inputs and provide reasonable defaults

- Output must be easily interpreted:
  - Displays both graphical and text output
  - Offers a variety of output options (for example, displaying model results in MARPLOT or importing into ESRI products)

Critical Assumptions

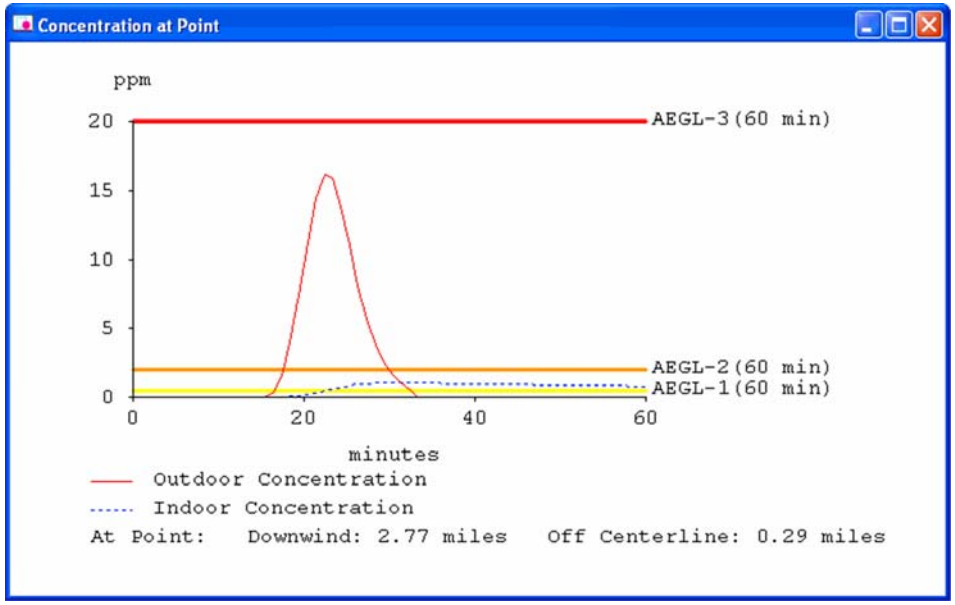


- Constant wind field
- Max distance: 10 km
- Max duration: 60 min
- Flat earth
- No explosive releases
- Chemical (not nuclear or biological)

ALOHA Sources and Scenarios

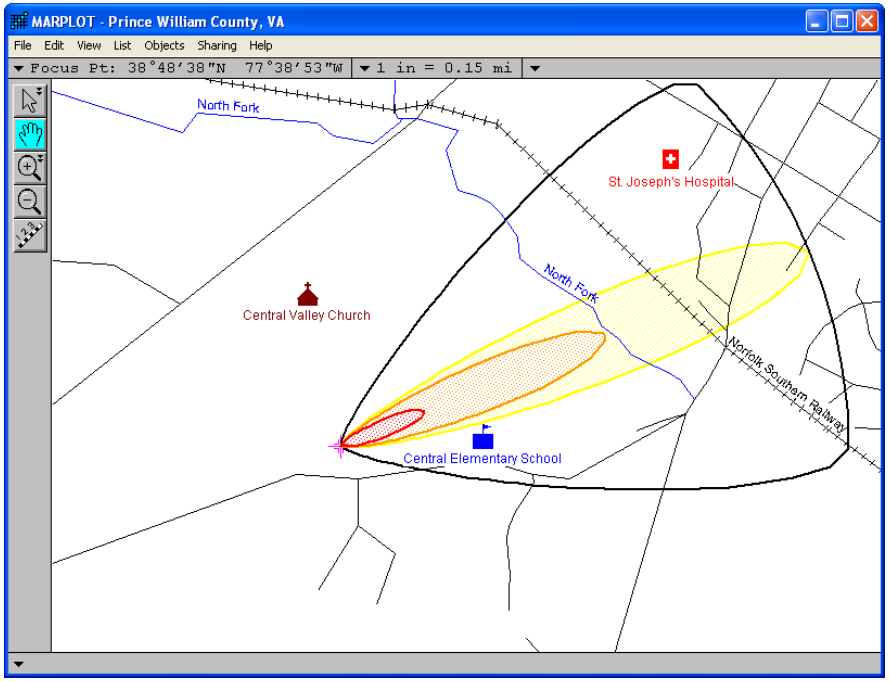
Source	Toxic Scenarios	Fire Scenarios	Explosion Scenarios
Direct			
Direct Release	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Puddle			
Evaporating	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Pool Fire)		Pool Fire	
Tank			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning		Jet Fire or Pool Fire	
BLEVE		BLEVE (Fireball and Pool Fire)	
Gas Pipeline			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Jet Fire)		Jet Fire	

Outputs

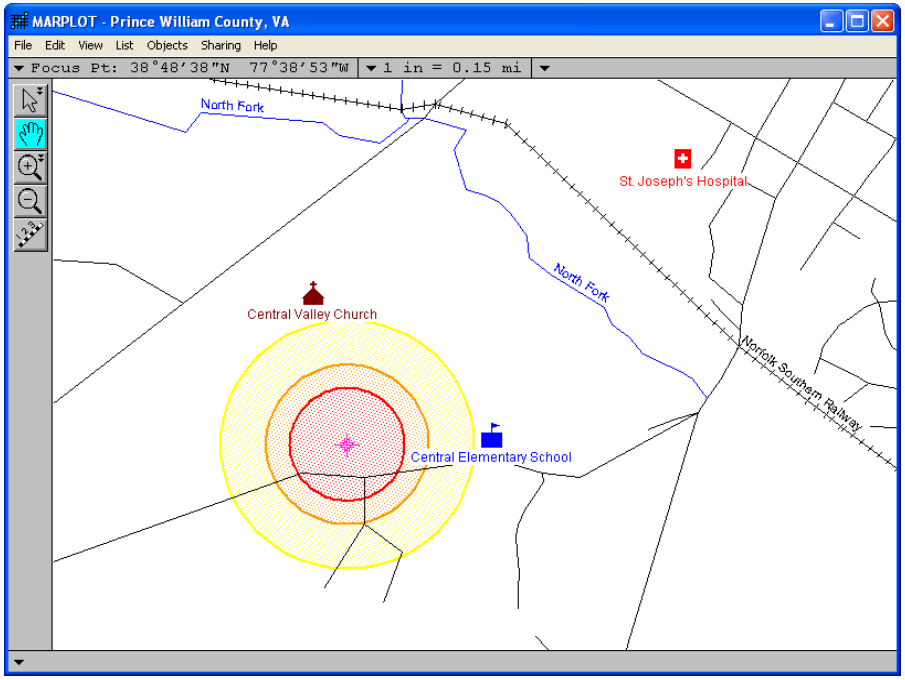


- Scenario Text Summary
- Source strength graphs
- Concentration graphs
- Threat zones (footprints)
- NOAA and Diagnostic Menus

ALOHA Threat Zone Plots



Traditional Toxic Threat Zone



BLEVE Thermal Radiation Threat Zone

New Features in ALOHA 5.4

- Five fire and explosions scenarios:
  - Jet Fires
  - Pool Fires
  - Flammable Areas (Flash Fires)
  - BLEVEs
  - Unconfined Vapor Cloud Explosions
- Users can now choose to use water as a ground type and as a ground roughness variable.

ALOHA 5.4.1 was developed in response to user feedback and because DOT requested a fire and explosion model to replace DOS-based ARCHIE.

Model Changes: Fires and Explosions

- For toxic releases, ALOHA uses a 3 - 5 minute averaging time. For a fire or explosion scenario, the averaging time is significantly shorter (10 or 20 seconds) to account for the instantaneous nature of the threat.

- One of ALOHA's strengths is its ability to account for time-dependent releases. Many of the fire and explosion algorithms used in ALOHA 5.4 had to be modified to work with the time-dependent source strength calculations.

Sensitivity Analysis - Fires and Explosions

Due to the nature of emergency response, sometimes users have to estimate their input values. The sensitivity analysis provides a way to assess where inaccurate input values would have the most significant effect on output values.

Jet Fire - Flare

Input Parameter	Relative Sensitivity
Wind Speed	0.074
Hole Size	0.929
Pressure	0.414

Algorithm Checks - Fires and Explosions

- Checked ALOHA's coded algorithms against the same algorithms programmed in MATHCAD, MATHEMATICA, or MATLAB.

- The algorithm check verified the accuracy of the ALOHA code when the output values showed no (or nominal) differences. The small differences were attributable to things such as roundoff error.

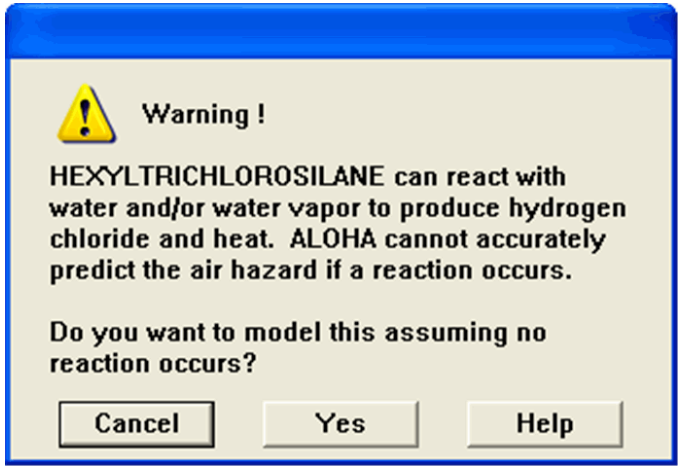
Usability Testing

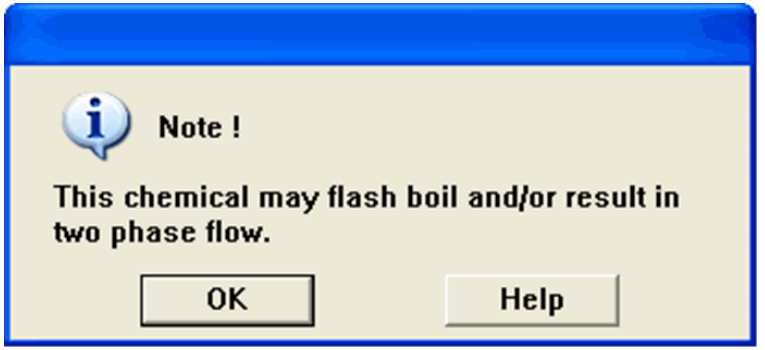
- User Centered Design
  - Complex drills were conducted to identify decision makers and the evolution of the decisions
  - User Domain Analysis
  - User Scenario Testing

No model can be evaluated independent of the context in which it is to be used.

Interactive User Interface

- ALOHA has an on-screen help system that is available anytime the program is on. Also, most dialog boxes have help buttons that take users directly to the help topic for that section.
- Notes and warnings appear to guide users at critical points in the model and make sure the user is aware of what the model is doing.





Model to Model Comparisons

- **GOAL**: Identify code errors and examine outliers
- Used fractional factorial design to prepare input values
- Compared results with CHEMS-PLUS and ARCHIE using six scenarios (source and dispersion checked separately):
  - Pure liquid release from a tank
  - Two-phase flow from a tank
  - Pure gas release from a tank
  - Cryogenic puddle evaporation
  - Non-cryogenic puddle evaporation
  - Release of gas from a gas pipeline

Additional Model Comparisons

- SHELTER: air exchange rates
- Scenarios from the *Workbook of Test Cases for Vapor Cloud Source Dispersion Models* (CCPS, AIChE): source strength and dispersion estimates
- DEGADIS: heavy gas dispersion

Model Comparison - Fires and Explosions

Sample Scenario Comparison Results - Propane Railcar BLEVE

Model	Fireball Diameter	Burn Duration	9.5 kW/m² Distance	5 kW/m² Distance
ARCHIE	271 yd	16 sec		
RMP*COMP			880 yd*	
HAM			709 yd	1013 yd
ALOHA	249 yd	14 sec	617 yd	850 yd

* RMP radiation level is distance to 2nd degree burns

ARCHIE - Automated Resource for Chemical Hazard Incident Evaluation
RMP*Comp - Risk Management Plan Guidance for Offsite Consequence Analysis
HAM - Maritime Hazard Assessment Model

ALOHA Strengths

- Links directly with CAMEO - Allows use of 80,000 synonyms to help ID chemical and has Facility Chemical Inventory data
- Automatically displays threat zones on MARPLOT (output can also be exported to ESRI products)
- Training tool/intuition builder
- Usability, accessibility, fitness to purpose
- Transportability
- Multiple time-dependent source models

ALOHA Weaknesses

- Liquids in pipes as a source/dual end ruptures
- No multiple met data input capability
- No elevated dense-gas releases
- Time dependent meteorology
- Complex topography

Continued Development

- Pool fires on water
- Add petroleum products to Chemical Library
- Water reactive calculations for byproduct source strengths (calculator?)
- Enhance network/web capabilities
- ChemTAP

Goal: Maintain Focus on First Responders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