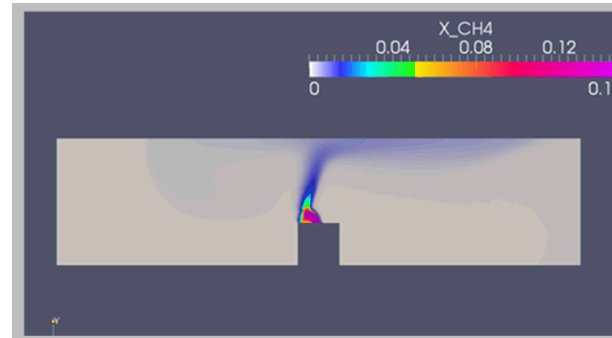
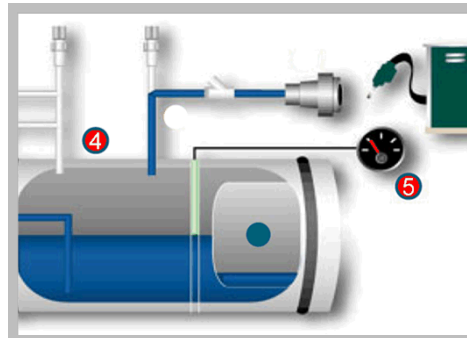
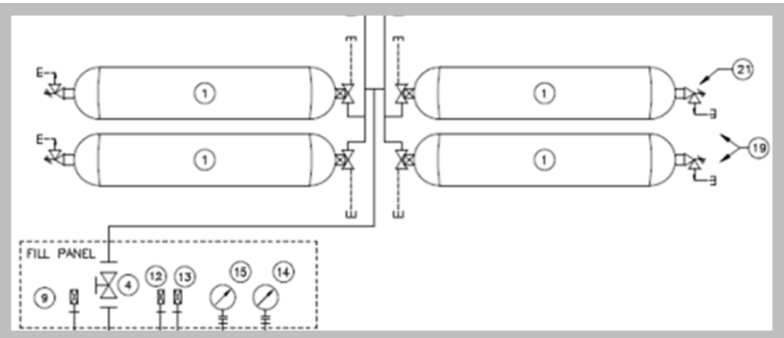


Exceptional service in the national interest



Physics and Risk Assessment Modeling

2016 Propane Autogas Technology Forum (PATF)

Aug. 10, 2016

Project sponsored by DOE Clean Cities:

Technical & Analytical Assistance

Radoslav Bozinoski, PhD

Sandia National Laboratories

Team Members

- Chris LaFleur
- Cathy Farnum
- Alice Muña
- Katrina Groth
- Rad Bozinoski
- Ethan Hecht
- Amanda Dodd
- Myra Blaylock

Project Motivation

- Provide scientific justification to code committees for improvements to codes and standards for alternative fuels vehicle maintenance facilities
- Develop **Risk-Informed** guidelines for modification and construction of maintenance facilities using consequence models

Talk Objectives

- Provide overview of physics modeling/risk assessment analysis
- Develop partnerships/collaborations with alternative fuels industry

New website: altfuels.sandia.gov

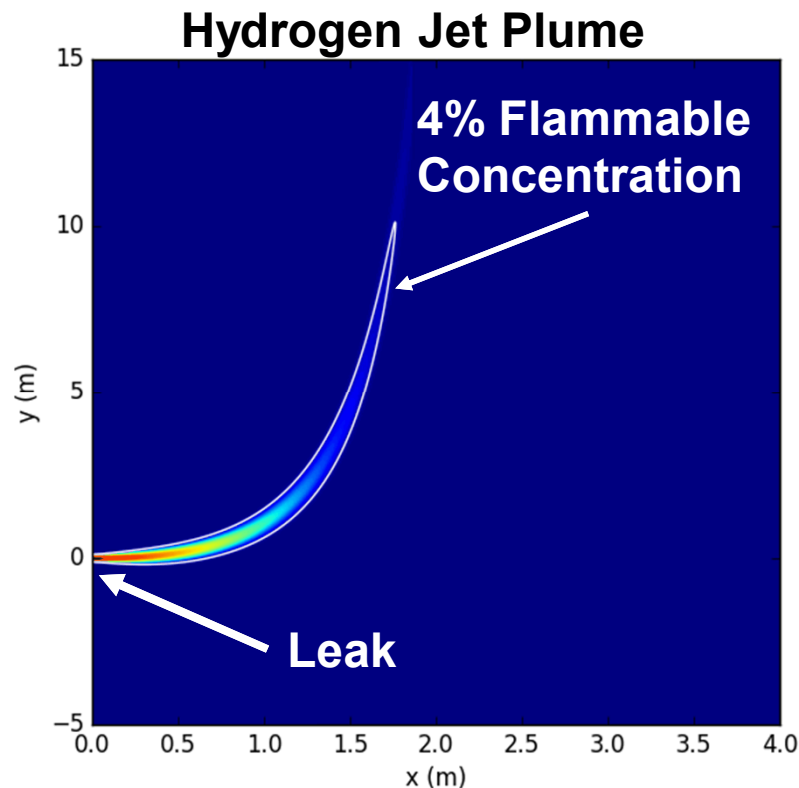
- Reports, videos, links, information, these slides

Modeling and Simulation

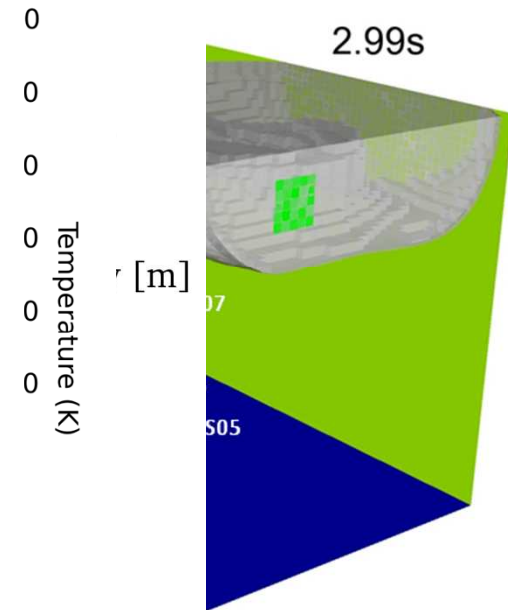
Physics modeling comes in two flavors

- Transient and Steady state 1D
 - Network flow solver
 - Release characteristics (plumes, accumulation)
 - Flammability

- Transient 3D
 - Safety



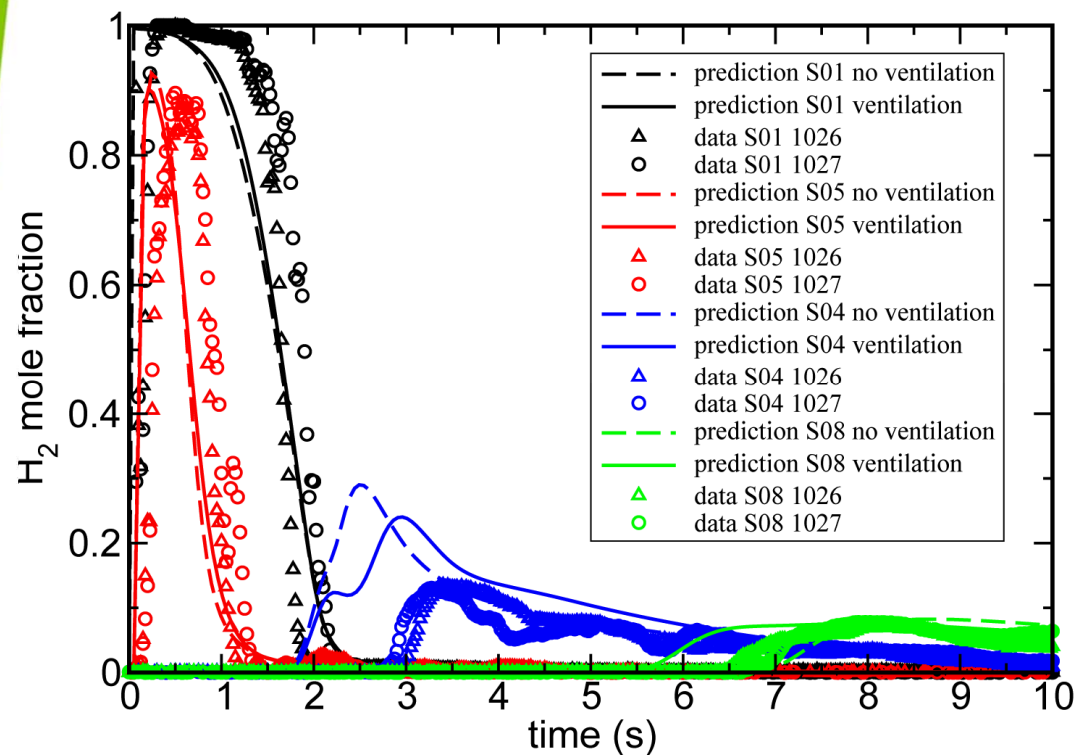
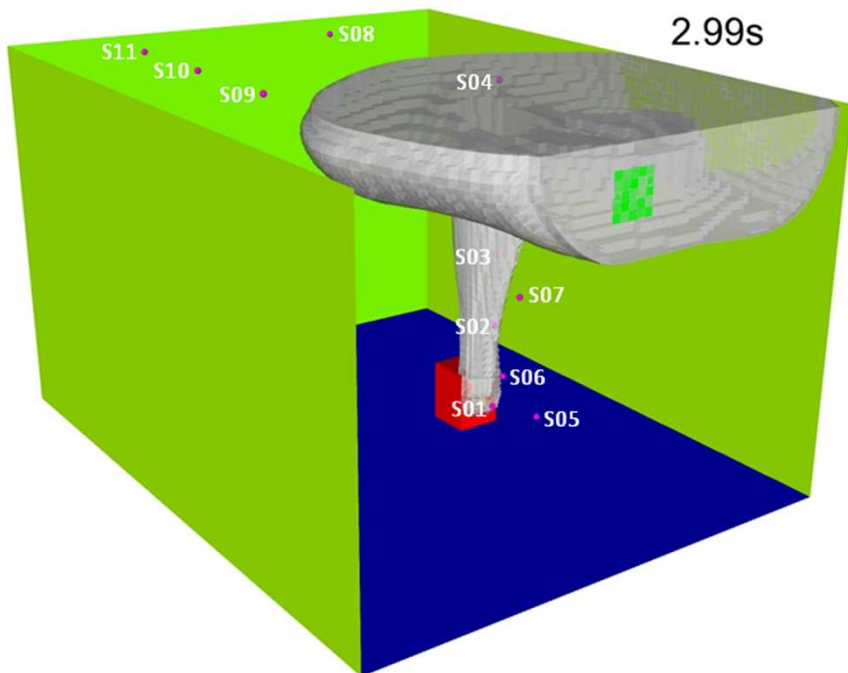
atures)



Methodology previously validated against large-scale hydrogen blowdown release experiments

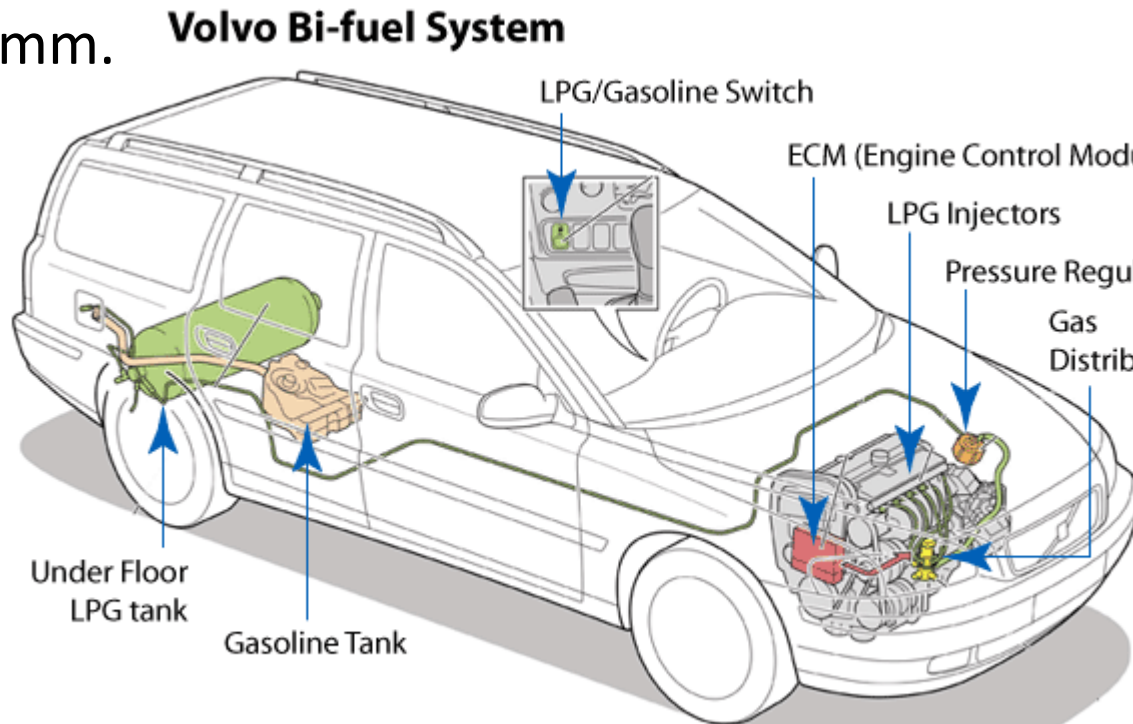
Blowdown release rates calculated via Sandia network flow solver

Winters, SAND Report 2009-6838.



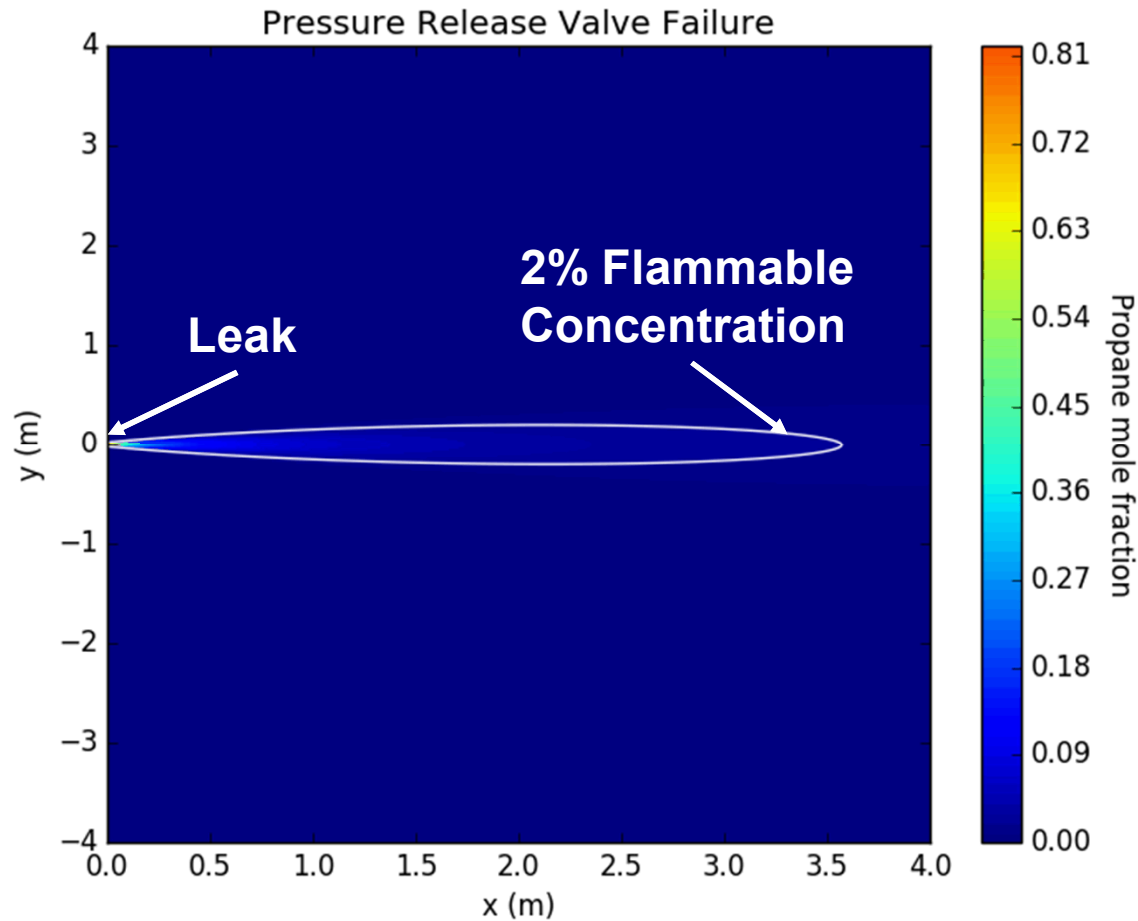
Example Propane PRV Leak Scenario

- Tank vol = 98 gal, 19.6 gal (20%) of liquid fuel.
- Tank pressure = 175 psi.
- Tank temperature = 294K
- Leak orifice (PRV) = 6.2mm.

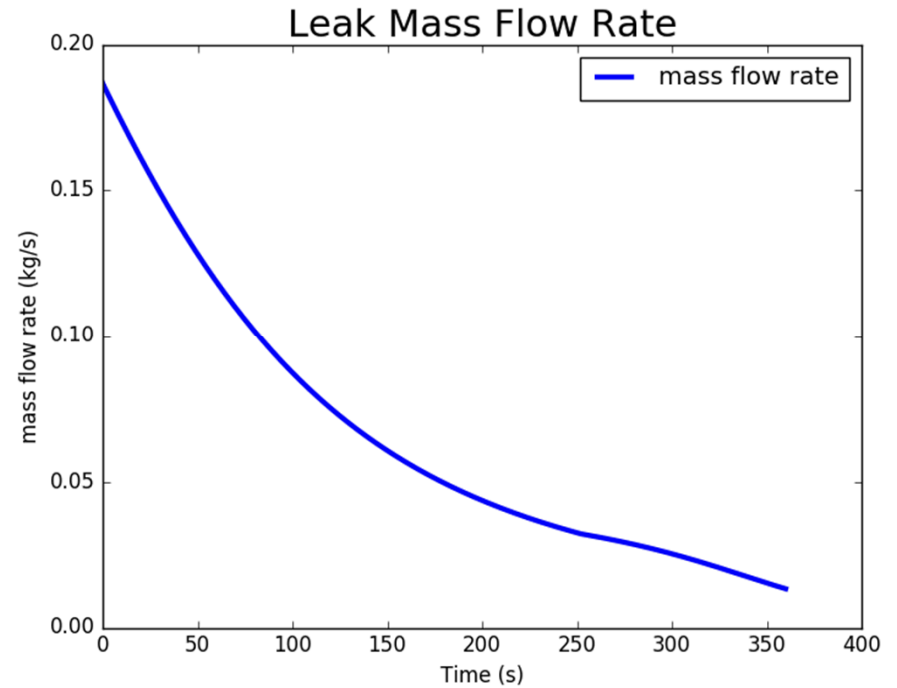
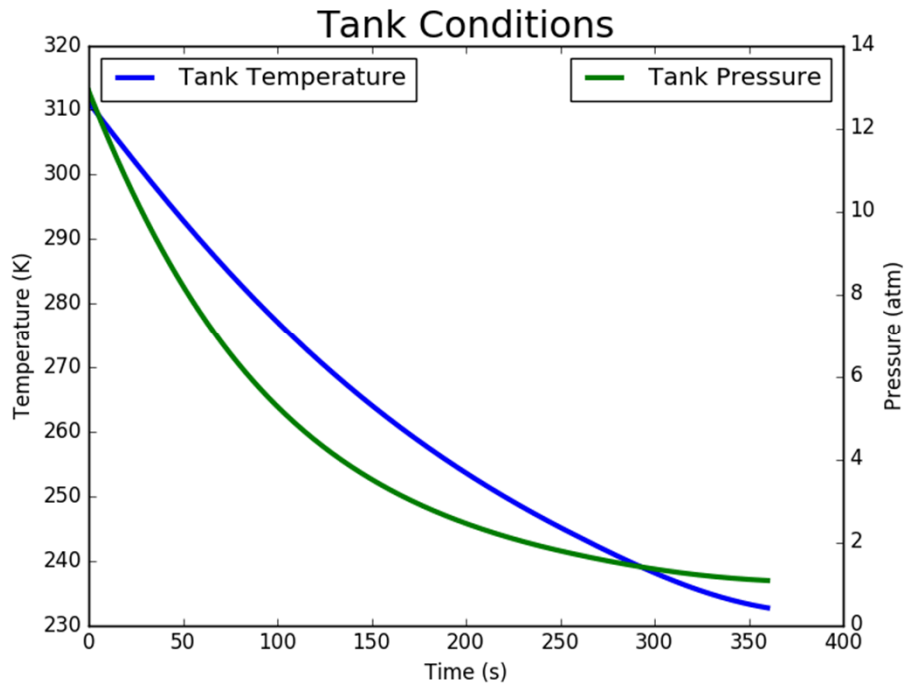


Plume Model Propane results

- Very Fast
- Doesn't interact with building and/or ventilation

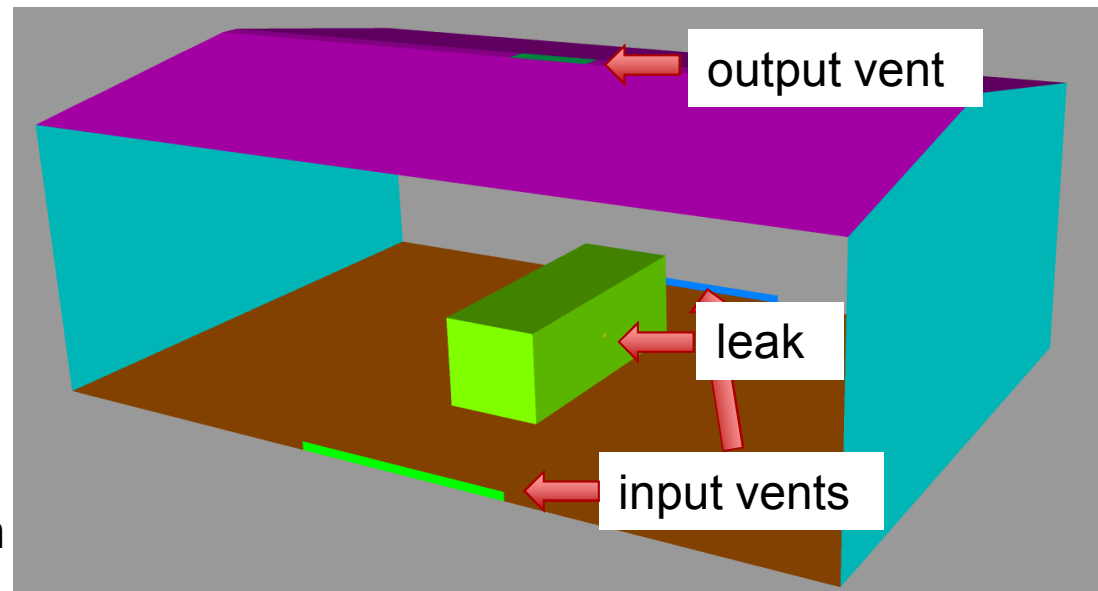


Can also generate leak boundary conditions

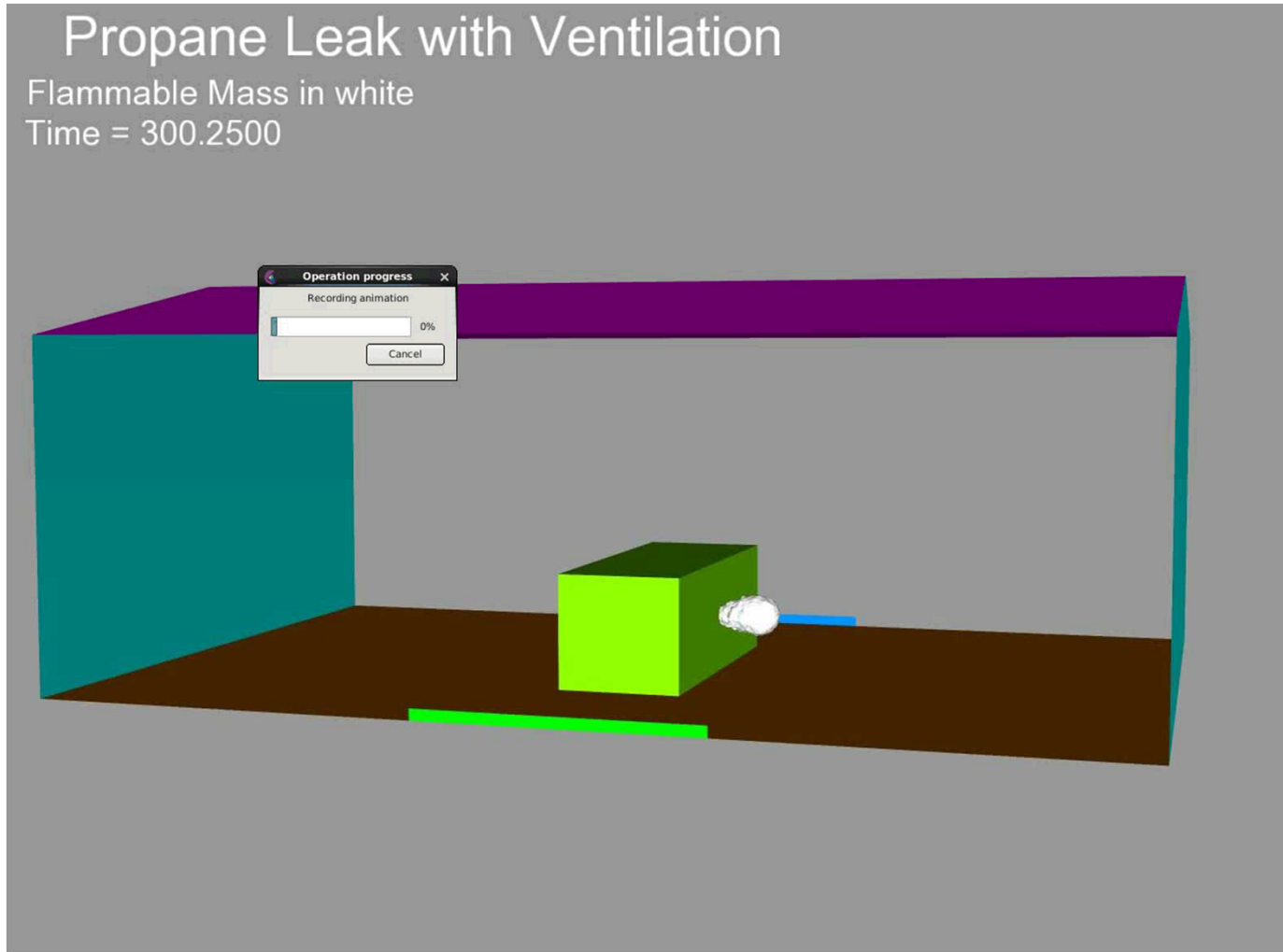


Maintenance Garage Specs

- Dimensions: 60' x 40' m x 20' ; 1:6 roof pitch
- Two inflow vents near the floor
 - Vent area for both: 10 ft²
 - Ventilation rate set to 5 air changes/hour (~100 cm/s inflow)
- One outflow vent at the ceiling
 - Simulations were run with top down and bottom up ventilation
- Vehicle modeled as a box
(18.7' x 6.6' x 7')



Bottom Up Ventilation

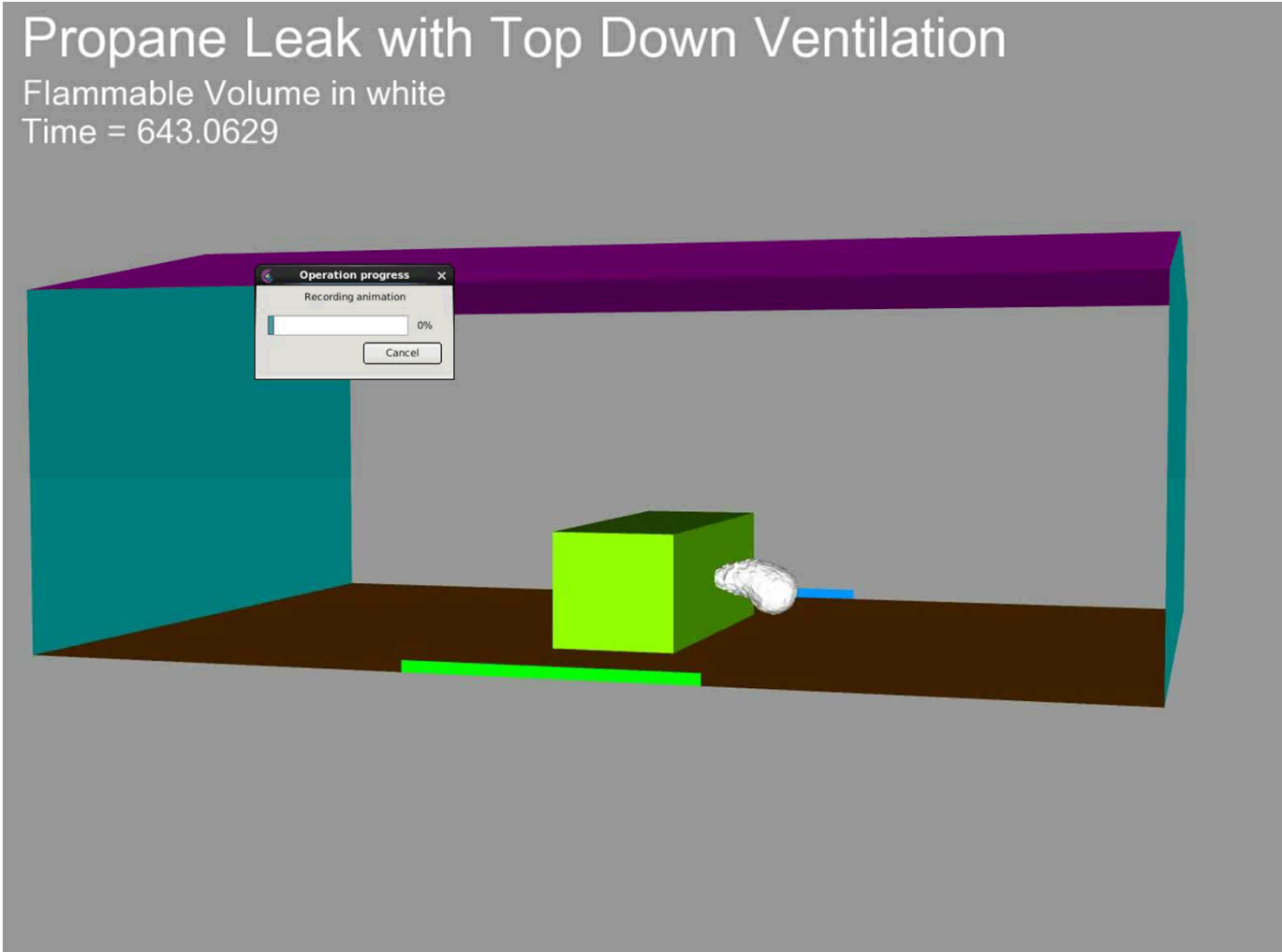


Top Down Ventilation

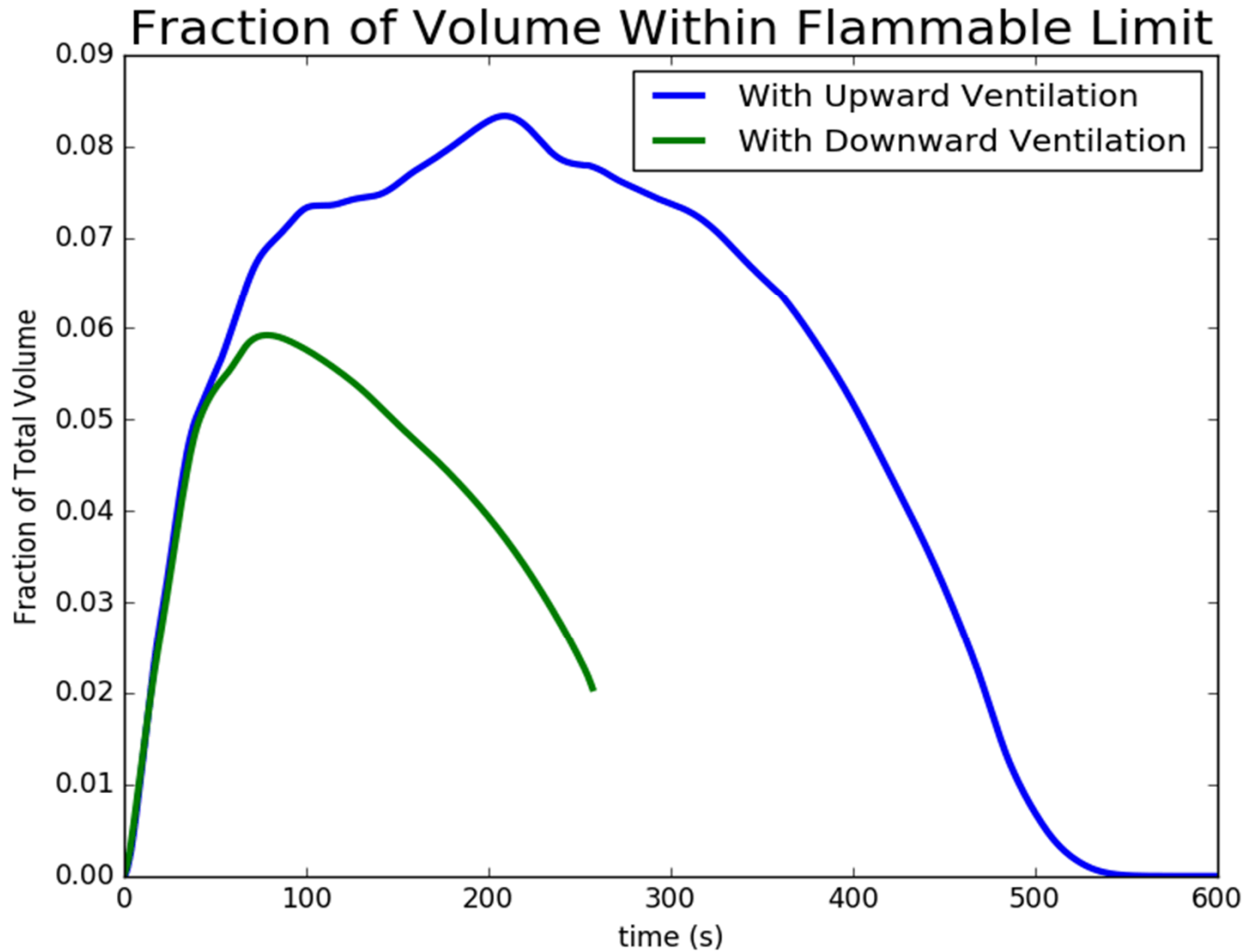
Propane Leak with Top Down Ventilation

Flammable Volume in white

Time = 643.0629



Ventilation Comparisons



Ventilation Comparisons

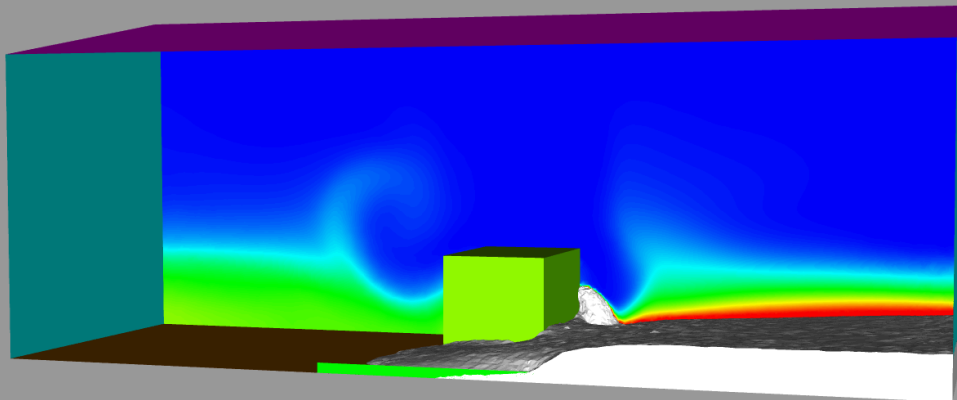
- Less flammable concentration with “Top Down” ventilation

Propane Leak with Ventilation

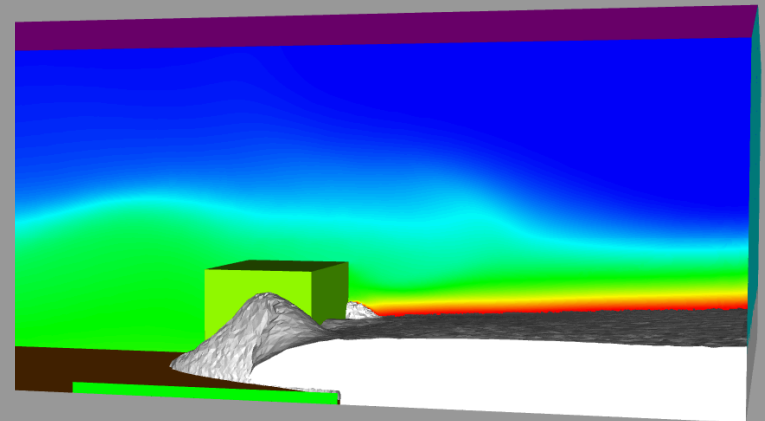
Flammable Volume in white
Time = 175 sec

Propane Leak with Top Down Ventilation

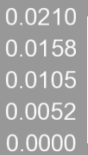
Flammable Volume in white
Time = 175 sec



XC3H8



XC3H8



Risk Assessment

- HyRAM functions in two modes
 - Physics mode: Models of hydrogen release for consequence modeling
 - Release characteristics (plumes, accumulation)
 - Flame properties (jet fires, deflagration within enclosures)
 - QRA mode: Probabilistic models for human harm from thermal and overpressure hazards
- Fast running: to accommodate rapid iteration
- Calculates common risk metrics
- Hydrogen Risk Assessment Model
hynam.sandia.gov (available for free download)

Future Opportunities

- Develop partnerships/collaborations with Propane Autogas community
 - Experiments to validate models
 - External expertise and knowledge needed to make an impact in propane autogas community
- Places where Sandia can help
 - Quantitative Risk Assessment (QRA)
 - Uncertainty Quantification of Model Parameters
 - How does leak size affect plume length?
 - Physics modeling

Thank you!

altfuels.sandia.gov